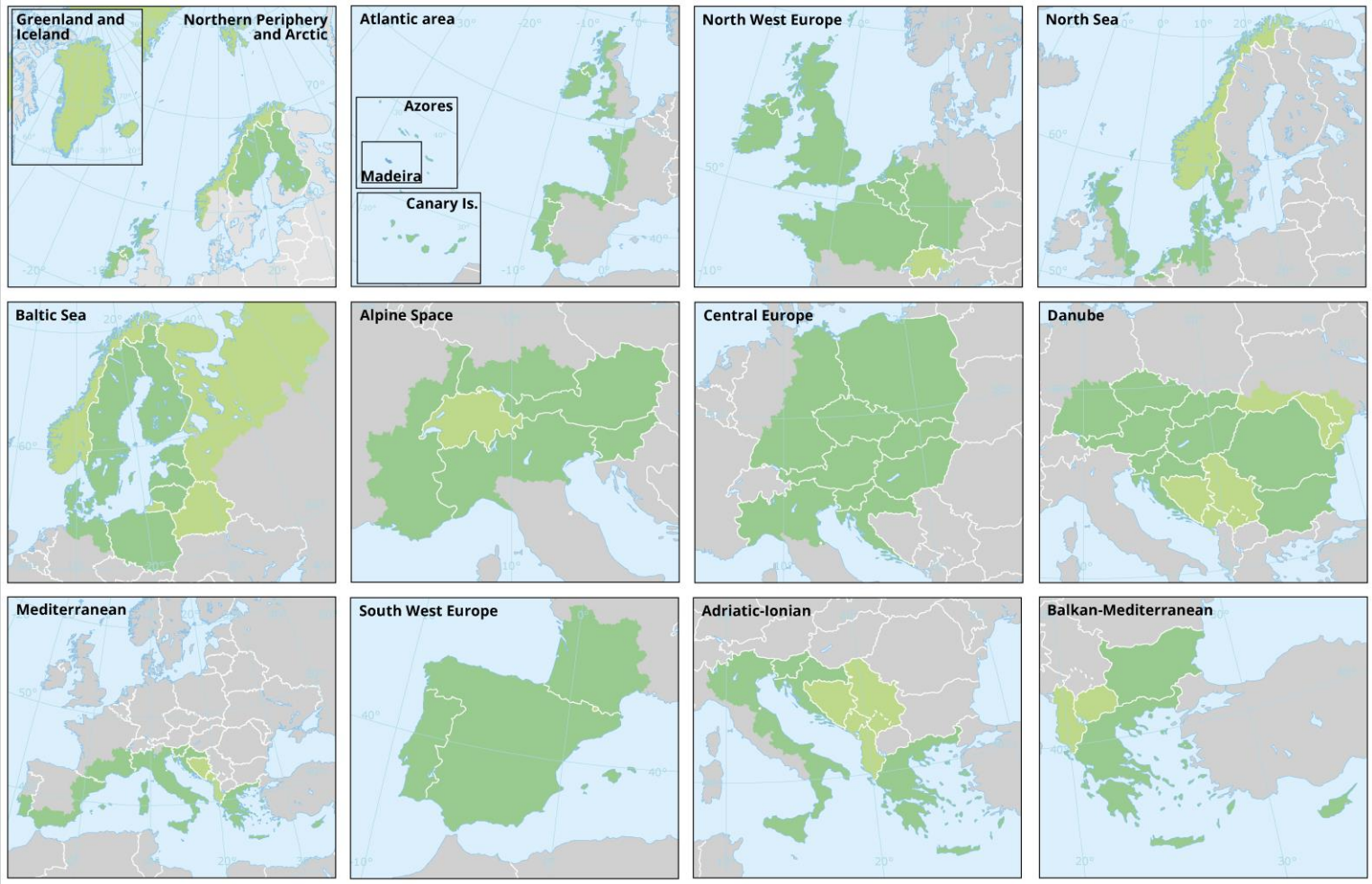
ETC/CCA Technical Paper 2018/4

Adaptation policies and knowledge base in transnational regions in Europe



Authors:

Emiliano Ramieri (Thetis), Margaretha Breil (CMCC), Sergio Castellari (EEA), Elisa Calliari (CMCC), Wolfgang Lexer (EAA), Stefan Fronzek (SYKE)

European Environment Agency
European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation

Cover graph: ETC/CCA and EEA
Layout: Margaretha Breil (CMCC)

ETC/CCA consortium partners: Fondazione CMCC- Centro Euro-Mediterraneo sui Cambiamenti Climatici, Charles University Environmental Center (CUNI), Aarhus University - Danish Center for Environment and Energy (DCE-AU), Umweltbundesamt GmbH - Environment Agency Austria (EAA), Associação para a Investigação e Desenvolvimento de Ciências (FC.ID), Fresh-Thoughts Consulting (FT), Met Office Hadley Centre (MO), Finnish Environment Institute (SYKE), THETIS S.p.A (THETIS), Helmholtz Centre for Environmental Research (UFZ), The Chancellor, Master and Scholars of the University of Oxford (UKCIP), Universidad Politécnica de Madrid (UPM), Wageningen Environmental Research (WER), Zentralanstalt für Meteorologie und Geodynamik (ZAMG)

More information on the European Union is available on the Internet (http://europa.eu).

DOI: 10.25424/CMCC/CLIMATE_CHANGE_ADAPTATION_IN_TRANSNATIONAL_REGIONS_2018

Suggested citation
Ramieri E., M. Breil., S. Castellari, E. Calliari, W. Lexer, S. Fronzek (2018) “Adaptation policies and knowledge base in Transnational regions in Europe”. European Topic Centre on Climate Change impacts, Vulnerability and Adaptation (ETC/CCA) Technical Paper 2018/4. DOI: 10.25424/CMCC/CLIMATE_CHANGE_ADAPTATION_IN_TRANSNATIONAL_REGIONS_2018.

European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation (ETC/CCA)
c/o Fondazione CMCC - Centro Euro-Mediterraneo sui Cambiamenti Climatici
V.le Berti Pichat 6/2
40127 Bologna, Italy
Web: http://cca.eionet.europa.eu/
Email: silvia.medri@cmcc.it

Acknowledgements

Coordination:

This activity has been coordinated by Sergio Castellari (EEA), Emiliano Ramieri (ETC/CCA) and Margaretha Breil (ETC/CCA).

Members of the Advisory Group:

Alessio Satta (Executive Secretary of Mediterranean Wetlands Initiative (MedWet)), Daria Povh (Priority Actions Programme/Regional Activity Centre (PAP/RAC) of the United Nations Environment Programme – Mediterranean Action Plan (UN Environment/MAP)), Eleonora Musco (Secretariat of the Carpathian Convention), Gheorghe Constantin (Ministry of Water and Forests, Romania; EUSDR), Idoia Arauzo González (Pyrenean Climate Change Observatory ((OPCC-CTP)), Irina Makarenko (Commission on the Protection of the Black Sea Against Pollution – Permanent Secretariat), Jean-Marc Venineaux (European Commission, Directorate General for Regional and Urban Policy (DG REGIO)), Jelena Miloš (European Commission, Directorate General for Climate Action (DG CLIMA)), Juan Terrádez Mas (Pyrenean Climate Change Observatory (OPCC-CTP)), Judith Estol (Delegation to the EU – Government of Catalonia), Károly Gombás (Ministry of Foreign Affairs and Trade and Ministry of Interior, Hungary; EUSDR PA5, ICPDR FP-EG), Krista Kampus (Council of the Baltic Sea States Secretariat; EUSBSR), Laura Alexandrov (National Institute for Marine Research and Development 'Grigore Antipa'), Manuel González Evangelista (INTERACT Programme), Marco Onida (European Commission, Directorate General for Regional and Urban Policy (DG REGIO)), Marianna Elmi (Permanent Secretariat of the Alpine Convention), Marianne Kroglund (Norwegian Environment Agency; Arctic Monitoring and Assessment Programme (AMAP)), Mitja Bricelj (Ministry of the Environment and Spatial Planning, Slovenia, EUSAIR), Nathalie Morelle (Permanent Secretariat of the Alpine Convention), Piero Lionello (University of Salento, Italy; Fondazione CMCC – Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy).

All authors would like to acknowledge Angel Aparicio (ETC/CCA), Wouter Vanneuville (EEA), José Ramon Picatoste (EEA), Christofer Ahlgren (European Commission, Directorate General for Climate Action (DG CLIMA)) and the members of the Advisory Group for the valuable information and feedback they provided during the development of this Technical Paper.

All authors would also like to thank Angiola Fanelli (Thetis), who developed the maps included in Section 1 and Annex 1, and Stephanie Fergusson (UKCIP) for the language check.

Finally, all authors would like to thank Jos Timmerman (ETC/CCA), who in 2017 participated at the first phase of this activity providing valuable contributions for creating foundations and shaping of this work.

Contents

List of Figures

List of Tables

List of Boxes

List of Acronyms

AACA	Adaptation Actions for a Changing Arctic
ACB	Alpine Climate Board
ACS	Association of Caribbean States
ADRION	Adriatic-Ionian Programme
AG8	EUSALP Action Group 8 on Risk Governance
AMAP	Arctic Monitoring and Assessment Programme
ASP	Alpine Space Programme (ASP)
AST	Adaptation Support Tool
BEAC	Barents Euro-Arctic Council (BEAC)
BMNT	Federal Ministry of Sustainability and Tourism
BSR	Baltic Sea Region
BwN	Building with Nature
CAMP	Climate Adapted Management Plan
CAPA	Climate Adaptation Platform for the Alps
CARICOM	Caribbean Community
CBC	Cross-Border Cooperation
CBSS	Council of the Baltic Sea States
CCA	Climate Change Adaptation
CCCCC	Caribbean Community Climate Change Centre
CIPRA	International Commission for the Protection of the Alps (French: Commission Internationale pour la Protection des Alpes)
CO_2	Carbon Dioxide
COP	Conference of Parties
CPMR	Conference of Peripheral Maritime Regions
CSO	Civil Society Organisations
CTP	Community of the Pyrenees
DFRM	Danube Flood Risk Management Plan
DG	Directorate General
DG CLIMA	Directorate-General for Climate Action
DG ECHO	Directorate-General for European Civil Protection and Humanitarian Aid Operations
DG REGIO	Directorate-General for Regional and Urban Policy
DRB	Danube River Basin
DRBMP	Danube River Basin Management Plan
DRPC	Danube River Protection Convention
DRR	Disaster risk reduction
DTP	Danube Transnational Programme
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
ECRA	European Climate Research Alliance
ECRAN	Environment and Climate Regional Accession Network
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EFTA	European Free Trade Association
EIB	European Investment Bank

EMFF	European Maritime and Fisheries Fund
EMME	Eastern Mediterranean and the Middle East
EMODnet	European Marine Observation and Data Network
ENI	European Neighbourhood Initiative
ENPI	European Neighbourhood and Partnership Instrument
ERA4CS	European Research Area for Climate Services
ERDF	European Regional Development Fund
ESA	European Space Agency
ESF	European Social Fund
ESIF	European Structural and Investment Funds
ESPON	European Spatial Planning Observation Network
ETC/CCA	European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation
EU	European Union
EUCC	Coastal & Marine Union
EUMC	EU Mediterranean Countries
EUSAIR	EU Strategy for the Adriatic and Ionian Region
EUSALP	EU Strategy for the Alpine Region
EUSBSR	EU Strategy for the Baltic Sea Region
EUSDR	EU Strategy for the Danube Region
EUSF	European Union Solidarity Fund
FP7	7th Framework Programme for Research
FYROM	Former Yugoslav Republic of Macedonia
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
GIS	Geographic Information System
GNSS	Global Navigation Satellite Systems
GWP	Global Water Partnership
HA	Horizontal Action
HELCOM	Helsinki Commission, Governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area
HIV	Human Immunodeficiency Virus
ICID	International Commission on Irrigation and Drainage
ICPDR	International Commission for the Protection of the Danube River
ICZM	Integrated Coastal Zone Management
IDMP CEE	Integrated Drought Management Programme Central and Eastern Europe
IPA	Instrument for Pre-Accession Assistance
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ISRBC	International Sava River Basin Commission
IT	Information Technology
IUCN	International Union for Conservation of Nature
JPI	Joint Programming Initiatives
KETs	Key Enabling Technologies
MAC	Madeira-Açores-Canarias
MCSD	Mediterranean Commission on Sustainable Development

MED	Mediterranean
MLS	Multi-Layer Safety
MPAs	Marine Protected Areas
MPCs	Mediterranean Partner Countries
MS	Member States
MSP	Maritime Spatial Planning
MSSD	Mediterranean Strategy for Sustainable Development
NAS	National adaptation strategies
NBS	Nature Based Solutions
NGO	Non-governmental organization
NPA	Northern Periphery and Arctic
NPP	Northern Periphery Programme
NSR	North Sea Region
NUTS	Classification of Territorial Units for Statistics
NWE	North West Europe
OCTs	Overseas Countries and Territories
OECS	Organisation of Eastern Caribbean States
OPCC	Pyrenean Climate Change Observatory (French: Observatoire Pyrénéen du Changement Climatique; Spanish: Observatorio Pirenaico del Cambio Climático)
ORs	Outermost Regions
OSPAR	Convention for the Protection of the marine environment of the North-East Atlantic (Oslo-Paris Convention)
PA	Priority Area
PAP/RAC	Priority Actions Programme/ Regional Activity Centre
POCTEFA	Programme Spain – France - Andorra (Spanish: Programa INTERREG V-A España-Francia-Andorra)
POCTEP	Cooperation programme Spain-Portugal (Spanish: Programa Operativo Cooperación Transfronteriza España-Portugal)
Q100	A flood event with probability of occurring once in every 100 years.
RACs	Regional Activity Centres
RCP	Representative Concentration Pathway
RENA	Regional Environmental Network for Accession
SDGs	Sustainable Development Goals
SDWG	Arctic Council's Sustainable Development Working Group
SEE	South East Europe programme
SLR	Sea Level Rise
SMEs	Small and Medium Enterprises
SRES	Special Report on Emissions Scenarios
SST	Sea Surface Temperature
SUDOE	South West Europe Programme
SWOT	Strengths-Weaknesses-Opportunities-Threats
TO	Thematic Objective
UBC	Union of the Baltic Cities
UfM	Union for the Mediterranean
UHI	Urban Heat island
UK	United Kingdom

UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNEP/MAP	United Nations Environment Programme - Mediterranean Action Plan
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VAO	Virtual Alpine Observatory
WG	Working Group
WMO	World Meteorological Organization

Executive Summary

The European Union (EU) Strategy on Adaptation to Climate Change, launched in 2013, has encouraged all EU Member States to adopt comprehensive adaptation strategies, including also cross-border issues (EC, 2013c). The evaluation of the EU Adaptation Strategy undertaken by the European Commission (EC) showed that the EU Strategy on Adaptation to Climate Change has stimulated some actions on cross-border climate risks between Member States, in particular river basins and Alpine areas, but further action is needed (EC, 2018d). It reiterates the relevant role that transnational (as well as cross-border and interregional) programmes, co-financed by the Cohesion or Regional Policy, play in promoting cooperation projects on CCA, including those developed in the frame of the EU macro-regional strategies. Furthermore, Climate-ADAPT supports cooperation across European countries and regions by fostering exchange of knowledge and experiences and supporting the setting-up of transnational governance structures to jointly cope with common challenges.

This technical paper provides an overview and analysis of the actions on climate change adaptation (CCA) and disaster risk reduction (DRR) promoted in 12 European transnational regions, as defined by the current INTERREG V B 2014–2020 programme, by considering:

- INTERREG cooperation programmes (i.e. INTERREG B) including the integrating European Neighbourhood and Partnership Instrument (ENI) and European Neighbourhood and Partnership Instrument (ENPI) when relevant;
- EU macro-regional strategies;
- International conventions;
- Other cooperation initiatives;
- Strategies and plans on CCA actually promoted within the 12 transnational regions;
- Projects and other knowledge sharing initiatives.

The analysis of cooperation initiatives on CCA and DRR across the 12 European transnational regions appears particularly appropriate as these regions provide a commonly accepted spatial subdivision of the European territory in the frame of the Cohesion Policy. Some of the transnational regions partially or totally overlap with EU macro-regional strategies and/or other relevant cooperation initiatives, such as sea and territorial conventions. These other initiatives active in some regions are relevant to integrating and even enhancing the role of CCA and DRR cooperation played by the European Territorial Cooperation. While EU macro-regional strategies have so far been established for only four transnational regions, the current European Territorial Cooperation programme has established funding programmes for all 12 transnational regions as part of the three pillars of the EU's economic, social and territorial development as pursued by the Cohesion Policy.

Methodologically, this study is based on a wide literature review including both scientific publications and technical reports regarding cooperation programmes, initiatives (including EU macro-regional strategies, and sea and territorial conventions) and projects. This study is also based on the consultation of a wide number of internet sources. The rich pool of information was firstly gathered and organised in 13 factsheets, one for each transnational region analysed plus an additional sheet focused on the EU Overseas Entities (which was used to elaborate Annex 1). This working material was then employed to draft the chapters of this paper. The assembled information and the final version of the technical paper

have been revised by an *ad hoc* informal advisory group, composed of representatives of different DGs (Directorate Generals) of the European Commission, EU macro-regional strategies, sea and territorial conventions and other cooperation initiatives and programmes.

The technical paper is structured in five chapters: chapter 1 provides an introduction to the INTERREG programme, in particular the component dedicated to transnational cooperation, as well as the 12 European transnational regions and the four currently operating EU macro-regional strategies. Chapter 2 provides an overview of the current and projected climate change impacts and vulnerability in these regions. Chapter 3 analyses the existing cooperation programmes and initiatives on CCA and DRR in each transnational region, while chapter 4 addresses the knowledge creation and sharing at a transnational level by providing some representative examples of cooperation projects on CCA and/or DRR along with an analysis of the role of the few existing knowledge platforms and centres active at transnational level. Finally, chapter 5 provides lessons learned and concluding remarks.

The key concluding remarks emerging from this study are the following:

- **Transnational cooperation (EU programmes, EU macro-regional strategies and other initiatives) has usefully supported climate change adaptation actions in those European regions faced with common transboundary climate change impacts and sharing common challenges.**

  INTERREG B transnational cooperation programmes have played a significant role in: (1) developing the knowledge base and tools which are needed to support climate change adaptation actions; (2) improving awareness-raising and capacity building; (3) promoting agenda-setting, inception and exploration of adaptation policies; and (4) piloting climate change adaptation initiatives in many countries.

  A significant role in supporting climate change adaptation actions is also played by the existing EU macro-regional strategies (EU Strategy for the Baltic Sea Region – EUSBSR, EU Strategy for the Danube Region – EUSDR, EU Strategy for the Adriatic and Ionian Region – EUSAIR, and EU Strategy for the Alpine Region – EUSALP) and international conventions (for example the Alpine Convention or the Carpathian Convention), which in general include climate change adaptation in their policy agendas. In some regions, other cooperation mechanisms, for example the Pyrenean Climate Change Observatory (OPCC), or specific CCA strategies and plans, for example the Baltic Sea Region Climate Change Adaptation Strategy and its Action Plan, are active in supporting climate change adaptation at the transnational level. The fact that INTERREG B programmes, EU macro-regional strategies and international conventions are addressing climate change and adaptation in their priorities and objectives demonstrates that policy awareness on the need for adaptation at transnational level is well established in the cooperation structures and their policy documents.

- **However, climate change adaptation is considered as a distinct priority only in few INTERREG V B 2014–2020 cooperation programmes.**

  In the current INTERREG V B programme, climate change adaptation is often considered a horizontal issue and compared to the previous funding period (2007–2013) it has lost direct relevance as a main funding priority or specific theme. In most of the transnational regions (even if not all), adaptation appears to be more and more perceived at a programme level as a

mainstreaming issue that is rather indirectly addressed in sectoral projects (e.g. on water management, flood management, fire risk management, etc.). Projects explicitly dedicated to the integration of adaptation into sectors have so far been limited in number, and the real mainstreaming of adaptation at a project level remains weak. Further support is thus needed, and increasing the funding priority of adaptation would be beneficial in this regard.

- **Climate change adaptation is addressed as a target, thematic objective, or action in all four existing EU macro-regional strategies. They overlap with the INTERREG transnational regions but do not usually cover the same area.**

  The EU macro-regional strategies are developed and implemented with the close involvement of national and regional (and sometimes local) government. Activities under these strategies can therefore be expected to have substantial impacts on policies within the participating countries, including where climate change adaptation is concerned. These macro-regional strategies are also implemented through funding provided by INTERREG B programmes for their governance process and specific projects. Moreover, the integration of adaptation into conventions and other cooperation initiatives has strengthened transnational efforts in those regions where such cooperation mechanisms exist. The depth of information in cooperation programmes and policy frameworks (INTERREG programmes, EU macro-regional strategies, conventions, other cooperation initiatives) strongly call for enhanced coordination among the different actors playing a role on CCA and DRR at the transnational level.

- **In some transnational regions, (North Sea, Northern Periphery and Arctic, Baltic Sea, Danube, Alpine Space and Mediterranean) common adaptation strategies or action plans that are politically relevant exist.**

  The few existing examples of transnational CCA strategies and action plans can be of inspiration to other transnational regions. However, due to the diversity of these regions across Europe, there is no one-size-fits-all approach, and the transnational CCA strategies or action plans are neither a necessary precondition for implementing adaptation actions, nor they are a guarantee of success. In order to deliver added value and become really effective, transnational adaptation strategies or plans need to meet specific requirements and tackle a number of challenges, such as: weakly developed multi-level governance mechanisms, a lack of or limited empowerment of coordination arrangements, limited capacity to actually coherently influence policy and decision-making at the national level with strategic orientation taken at the transnational scale, and limited availability of resources. Attachment to existing structures (e.g. EU macro-regional strategies or conventions) and reinforcement of existing multi-level governance mechanisms might help in this regard.

- **Transnational cooperation contributes to the development and exchange of region-specific knowledge among countries and stakeholders. Most transnational projects focus on 'soft actions' and are not expected to directly implement concrete measures on the ground. Evidence of practical application of knowledge and products generated by projects is limited.**

  Given the scope of transnational cooperation and the objectives of the INTERREG B programmes, transnational projects on CCA and DRR mainly focus on knowledge generation and sharing, awareness raising, capacity-building, networking and cross-country exchange. Typical products and activities at a transnational level comprise studies, recommendations, manuals, guidelines,

awareness-raising campaigns, collection and dissemination of good practice examples, etc. Therefore, the focus of projects is mostly on 'soft actions' rather than on the implementation of specific measures. Implementation in practice is regularly left to the post-project phase, which is often neglected due to a lack of ownership, commitment and clear responsibilities for further use of results which also depends on the end of funding as well as due to lack of a durable business and/or capitalisation model. It can nevertheless be stated, that the transnational projects have contributed to public and policy awareness of the need for adaptation at national and regional levels. In some cases, practical implementation might have occurred, but information providing evidence of this may not have been recorded or easily accessed. In any case, it is important that the optimization of project outcome transferability is planned and organised early on, for example developing a capitalisation plan and clearly identifying post-project roles and resources in advance as part of the project life cycle.

- **In the field of transnational cooperation, 'cluster projects' have been key for empowering stakeholders and expanding networking, which should facilitate the potential implementation of actions.**

  Cluster projects provide support and facilitate interaction and networking among similar projects running in the same region and/or engaging a wide arena of stakeholders in capitalisation, transfer and user-oriented preparation of project results. Therefore, the main purpose of cluster projects is to improve the communication of project results in order to increase the visibility and capitalisation in specific thematic areas. A key advantage of participating in a cluster project relates to the resulting increase in visibility of the projects and their results at a higher level which, in turn, also raises the awareness of politicians at an EU level (INTERREG NSR, 2015b). These projects are consequently expected to generate lasting impacts that have an influence on transnational and national adaptation policies, but this is rarely – and should be specifically – evaluated.

- **Knowledge creation and sharing at the transnational level is largely project-based. Dissemination and transfer of knowledge created by projects can be significantly enhanced by structured initiatives (climate change adaptation platforms and knowledge sharing centres and networks) specifically aiming at providing knowledge support to policy and decision-making at the level of transnational regions.**

  Structured experiences of knowledge-sharing at transnational level focused on climate change adaptation and/or disaster risk management are limited in number. To improve these efforts, climate change adaptation platforms and knowledge-sharing centres and networks can further play a relevant role. These knowledge-sharing initiatives should be linked with existing transnational cooperation mechanisms and actors (principally EU macro-regional strategies and sea or land-based conventions). If this is not possible, another option could be to integrate the materials provided by these platforms, centres and networks into already existing infrastructure at the national and/or European level, including the European Climate Adaptation Platform – Climate-ADAPT.

1 Introduction

1.1 Objectives and applied methodology

The European Union (EU) Strategy on Adaptation to Climate Change (EC, 2013c) aims to make Europe more climate-resilient (Figure 1.1). Taking a coherent approach by complementing the activities of Member States (MS), it promotes adaptation action across the EU, ensuring that adaptation considerations are addressed in all relevant EU policies, i.e. mainstreaming, promoting greater coordination, coherence and information and good practice sharing.

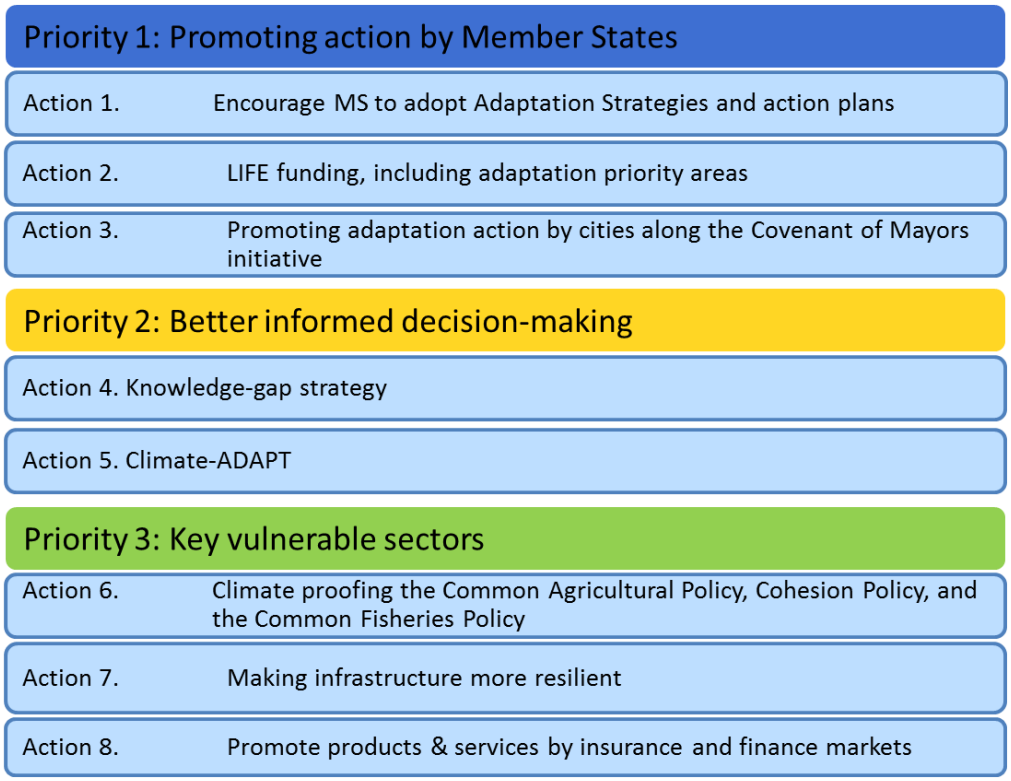


Figure 1.1: The EU Adaptation Strategy in a nutshell
(source: European Commission, DG CLIMA).

The EU Adaptation Strategy also includes a specific action, which aims to further develop and improve the perception of the Climate-ADAPT platform as a practical 'first-stop shop' for adaptation information in Europe. Supporting cooperation across European countries and regions is one of the key goals of Climate-ADAPT, aiming to foster exchange of knowledge and experiences, and supporting the setting-up of transnational governance structures to jointly cope with common challenges (EEA, 2018b).

The evaluation of the EU Adaptation Strategy (published in 2018) undertaken by the European Commission (EC) showed that the EU Strategy on Adaptation to Climate Change has stimulated some actions on cross-border climate risks between Member States, in particular in river basins and Alpine areas, but further action is needed (EC, 2018d). Transnational (as well as cross-border and interregional) programmes, co-financed by the Cohesion or Regional Policy[1], are therefore expected to continue

[1] http://ec.europa.eu/regional_policy/en/policy/what/investment-policy/

playing an important role in promoting cooperation projects on climate change adaptation, including those developed in the frame of the EU macro-regional strategies. Furthermore, this evaluation highlighted that approaching Climate Change Adaptation (CCA) as a global public good to tackle cross-border risks may reveal opportunities to strengthen international cooperation on resilience (EC, 2018d).

In this context, some important issues on the European Regional Development Fund (ERDF) were raised during the stakeholder consultation[2] which is part of the evaluation process of the EU Adaptation Strategy[3]. For example, difficulties encountered under the ERDF programme in prioritising adaptation were criticised (EC, 2018c): however, it was noted that in general terms, the introduction of provisions to make sure that a minimum share of the entire resources is dedicated to the Thematic Objective 5 (resilience, adaptation) had ensured that all programmes had committed at least the required minimum share. During the consultation not all stakeholders showed confidence that the requirements were fully complied with; however, the preparatory documents supporting the evaluation indicated that the introduction of these provisions had been effective in encouraging a deeper and more active Member State response (EC, 2018b). While this refers to larger infrastructure investments financed with the help of ERDF funding, it emerged from the preliminary evaluation results that *"(1) smaller investments and investments financed from other studies do not thoroughly consider needs for adaptation to future climate and (2) National Adaptation Strategies (NAS) have difficulties in identifying and tackling challenges related to cross-border or transnational issues*" (EC, 2018c).

This ETC/CCA paper analyses cooperation programmes, initiatives and projects on climate change adaptation developed at the transnational level in Europe, explicitly referring to the 12 transnational regions defined by the current INTERREG V B 2014–2020 programme[4]. These regions are characterised by common economic, social and environmental characteristics and tend to share common climate change challenges. The analysis of cooperation on climate change adaptation through the lens of these 12 regions appears particularly appropriate as they provide a commonly accepted spatial subdivision of the European territory in the frame of the EU- Cohesion Policy. As specifically elaborated in the other sections of this chapter, some of the transnational regions partially or totally overlap with EU macro-regional strategies and/or other relevant cooperation initiatives, such as sea and territorial conventions. The role of the latter in supporting climate change adaptation at transnational level is equally discussed in the paper.

Adaptation actions are closely related to disaster risk reduction (DRR). Given the evident commonalities, the analysis of transnational cooperation initiatives on climate change adaptation addressed in this paper is therefore also extended to DRR issues, providing that response to the latter can also contribute to improve the long-term adaptation capacity. Indeed, the already mentioned EU Strategy on Adaptation to Climate Change recommends the two should be closely related and implemented in synergy and full coordination. CCA and DRR policies pursue common objectives, including the management of climate-related risks and building of climate-resilient societies (EEA, 2017a). A wide number of climate-related risks can be triggered by climate extremes and exacerbated by climate change directly (heavy

[2] https://ec.europa.eu/clima/consultations/evaluation-eus-strategy-adaptation-climate-change_en

[3] https://ec.europa.eu/clima/events/articles/0119_en

[4] The INTERREG V B programme also includes other three cooperation regions, which are located outside Europe: Caribbean area, Amazonia and Indian Ocean area. As the paper aims to focus on the European continent, information on these three areas are reported in Annex 1 and are not part of the analysis.

precipitation, windstorms, storm surges, heatwaves, droughts, etc.) or indirectly (river and sea floods, forest fires, coastal and soil erosion, landslides, avalanches, etc.). Improved coherence in the knowledge base, policies and measures of CCA and DRR can reduce duplication of efforts and improve coordination (EEA, 2017a). Moreover, as holds true for climate change, a number of DRR related challenges (e.g. flooding in transnational river basins or storm surge affecting coastal areas of more than one country belonging to the same sea basin or sub-sea basin) assume particular relevance at the scale of transnational regions, calling for a strong cooperation between countries.

Hence, this study examines the interventions regarding climate change adaptation and disaster risk reduction planned and implemented mainly in 12 European transnational regions by considering:

- INTERREG cooperation programmes; i.e. INTERREG B, including the integrating European Neighbourhood and Partnership Instrument (ENI) and European Neighbourhood and Partnership Instrument (ENPI) when relevant;
- EU macro-regional strategies;
- Conventions;
- Other cooperation initiatives;
- Strategies and plans on climate change adaptation promoted within the 12 transnational regions;
- Projects and other knowledge sharing initiatives.

Methodologically, this study is based on a wide literature review including both scientific publications and technical reports. Relevant information on cooperation programmes (including INTERREG programmes), initiatives (including EU macro-regional strategies and sea and territorial conventions) and projects is not always accessible in publications or reports. In addition, the paper is also based on the consultation of a wide number of internet sources. The rich pool of information was gathered and organised in 13 factsheets, one for each transnational region analysed in the paper plus a further sheet which focuses on the EU Overseas Entities (which was used to elaborate Annex 1). This working material was then employed to draft the chapters. The compiled information (in the form of factsheets) and contents of the study have been verified through an *ad hoc* informal advisory group, composed of representatives of different DGs of the European Commission, EU macro-regional strategies, sea and territorial conventions and other cooperation initiatives and programmes, who were invited on a voluntary base to provide feedback and suggestions for the developed contents.

The paper is structured in five chapters, including this introduction. The following three sections of the introduction provide an overview of the INTERREG programme, in particular its component dedicated to transnational cooperation (sections 1.2 and 1.3), and of the 12 transnational regions considered in the analysis, together with their links to the four currently operating EU macro-regional strategies (section 0). For each of the 12 regions, chapter 2 illustrates the main current and projected climate change impacts and vulnerabilities, which are particularly relevant at the transnational scale. Chapter 3 focuses on the analysis of existing cooperation programmes and initiatives on climate change adaptation (and DRR), describing for each region: the relevance of INTERREG cooperation programmes for climate change adaptation; the role of EU macro-regional strategies, sea and territorial conventions and other cooperation initiatives; transnational strategies and plans on climate change adaptation that have been developed and implemented. Chapter 4 discusses knowledge creation and sharing at the transnational

level. For each region a number of representative examples of cooperation projects on CCA and/or DRR are illustrated (section 4.1), together with the analysis of the role that the few existing knowledge platforms and centres can play in supporting adaptation policies and measures (section 4.2). Finally, chapter 5 recaps some lessons learned from the performed analysis and provides conclusive remarks.

1.2 Transnational cooperation programmes

Climate change policies also require, in different geographic contexts, transnational policy initiatives and forms of governance which involve different levels of (regional, local) government as well as private initiatives of different kinds (Bulkeley and Jordan, 2012), while often transcending the national governance level. A number of reasons for extending the country level in favour of transnational cooperation can be sought in relation to adaptation and disaster risk reduction.

On the one hand, concepts for adaptation to a changing climate and DRR are often developed and framed by international policies and strategies (Dzebo and Stripple, 2015), while implementation depends on action at local or regional levels, being to a large extent connected to land use and spatial planning strategies (Van Well and Scherbenske, 2014; Glaas and Juhola, 2013). Thus, adaptation can be seen as a case of multi-level governance in which the implementation of locally specific solutions is driven as much from local knowledge about needs and resources and by 'soft forms' of governance such as 'agenda setting' as from national guidance and policy frameworks (Dzebo and Stripple, 2015; Bulkeley et al., 2012; Glaas and Juhola, 2013).

On the other hand, commonality of problems across borders potentially define new alliances, such as those between cities (Kern and Bulkeley, 2009) or those among entities situated within a common geographic space and sharing vulnerable environmental resources such as a river or sea basin. Both the similarity of problems and the need to manage shared resources are seen as strong drivers for cross-border and transnational actions (Glaas and Juhola, 2013).

In the European context, transnational regions and macro-regional strategies are, in some cases, consolidating a new layer of multi-level governance in which the EU attempts, from different angles and levels of aggregation, to involve sub-national units of government in addressing shared challenges and opportunities across Member States (Gløersen et al., 2016), creating a mix of institutional design which is capable of "*integrating top-down and bottom-up initiatives, as well as normative and regulatory institutional guiding elements*" (Van Well and Scherbenske, 2014).

While EU macro-regional strategies have so far been established only for four transnational regions, the current European Territorial Cooperation[5] programme has established funding programmes for 12 continental transnational regions as part of the three pillars of the Union's economic, social and territorial development as pursued by the EU Cohesion Policy[6]. The focus on the sub-national rather than the Member States' level has been part of the EU regional policies since the establishment of ERDF in 1975, and is intended to encourage the involvement of subnational interests in community policy (Hooghe and Keating, 1994, p. 371). With respect to CCA and risk assessment strategies, collaboration between border regions belonging to the same functional geographic space brings potential advantages for the creation of awareness, skills, know-how and motivation of authorities, experts and other

[5] http://ec.europa.eu/regional_policy/en/policy/cooperation/

[6] http://ec.europa.eu/regional_policy/index.cfm/en/policy/what/investment-policy/

stakeholders in facing common or similar climate-related challenges. While the climate actions financed under the EU LIFE[7] and the HORIZON 2020[8] programmes aim to create capacity for directly addressing climate change, structural funds seek to ensure that structural investments bring the desired long-term sustainable benefits, taking into account risks from a changing climate (EC, 2013b).

The availability of dedicated funding for transregional initiatives is one of the characteristics that distinguishes INTERREG programmes (a short overview on INTERREG programmes is provided in section 1.3.1) from other instruments for transnational cooperation such as EU macro-regional strategies, international conventions, and cooperation programmes promoted by regional institutions. Yet these initiatives are strongly interlinked most of the time. For instance, some INTERREG programmes support sea conventions (Helsinki Commission (HELCOM, 1992)), Oslo-Paris Commission (OSPAR, 1992), Barcelona Convention (1995), Bucharest Convention (Commission on the Protection of the Black Sea Against Pollution, 1994) or other territorial conventions (Alpine (1995) and Carpathian Convention (2003)) covering the same or overlapping territory. In the case of EU macro-regional strategies, the link is even more explicit, with transnational regions encouraging the development, coordination and implementation of the former as one of their objectives. Macro-regional strategies and their links with transnational cooperation are discussed in section 1.3.2.

The chapter concludes by briefly describing the thematic and geographical scope of the 12 transnational regions: Northern Periphery and Arctic, Atlantic Area, North West Europe, North Sea, Baltic Sea, Alpine Space, Central Europe, Danube, Mediterranean, South West Europe, Adriatic-Ionian and Balkan-Mediterranean. The Caribbean, Amazonia and Indian Ocean cooperation programmes are treated in detail in Annex 1.

1.3 Setting the scene: Cooperation between regions and countries

1.3.1 European Territorial Cooperation – INTERREG

The European Territorial Cooperation programmes are part of the instruments for the implementation of the EU Cohesion Policy and contribute to enhancing the "*harmonious and balanced integration of the territory of the Union by supporting cooperation on issues of Community importance*" (EU, 2013a). Better known as INTERREG, this group of programmes is aimed at addressing complex problems that transcend Member State boundaries and thus necessitate a common approach and multiple actors (both public and private) for their effective solution. It is based on three concepts: (1) sharing, in terms of knowledge or other assets; (2) integrating, by means of long-term partnerships across borders that enhance trust and mutual understanding; and (3) improving the quality of life, by, *inter alia*, reducing the risk of natural hazards (EC, 2011b). European Territorial Cooperation is built around three strands:

1. INTERREG A (cross-border cooperation) supports cooperation between Classification of Territorial Units for Statistics (NUTS) III regions9 from at least two different Member States lying

[7] The EU LIFE programme is the funding stream identified by the EU Adaptation strategy (EC, 2013c); http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.getProjects&themeID=111. See also Box 1.2.

[8] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/climate-action-environment-resource-efficiency-and-raw-materials

[9] http://ec.europa.eu/eurostat/web/nuts/background

directly or adjacent to the borders. With 37.5% of the EU population living in border areas, the programme seeks to tackle the common challenges and exploit the growth potential between neighbouring lands and maritime frontiers.

2. INTERREG B (transnational cooperation) unites larger territories at NUTS II level to promote better cooperation and regional development by a joint approach to common issues. These include, but are not limited to, matters such as communication corridors, flood management, international business and research linkages, and the development of more viable and sustainable markets.

3. INTERREG C (interregional cooperation) works at pan-European level to reinforce the effectiveness of the Cohesion Policy and includes all EU Members States and the European Free Trade Association (EFTA) countries. It consists of INTERREG Europe10, Urbact III11, Interact III12 and the European Spatial Planning Observation Network (ESPON)13, which are broadly set for the exchange of experiences and best practices, and the analysis of development trends pursuant to the effectiveness of the cooperation programme.

Figure 1.2 provides a schematic representation of INTERREG B within EU policies.

[10] https://www.interregeurope.eu/

[11] http://ec.europa.eu/regional_policy/index.cfm/en/atlas/programmes/2014-2020/Territorial%20co-operation/2014tc16rfir003

[12] http://www.interact-eu.net/

[13] https://www.espon.eu/main/Menu_Programme/Menu_ESPON2020Programme/

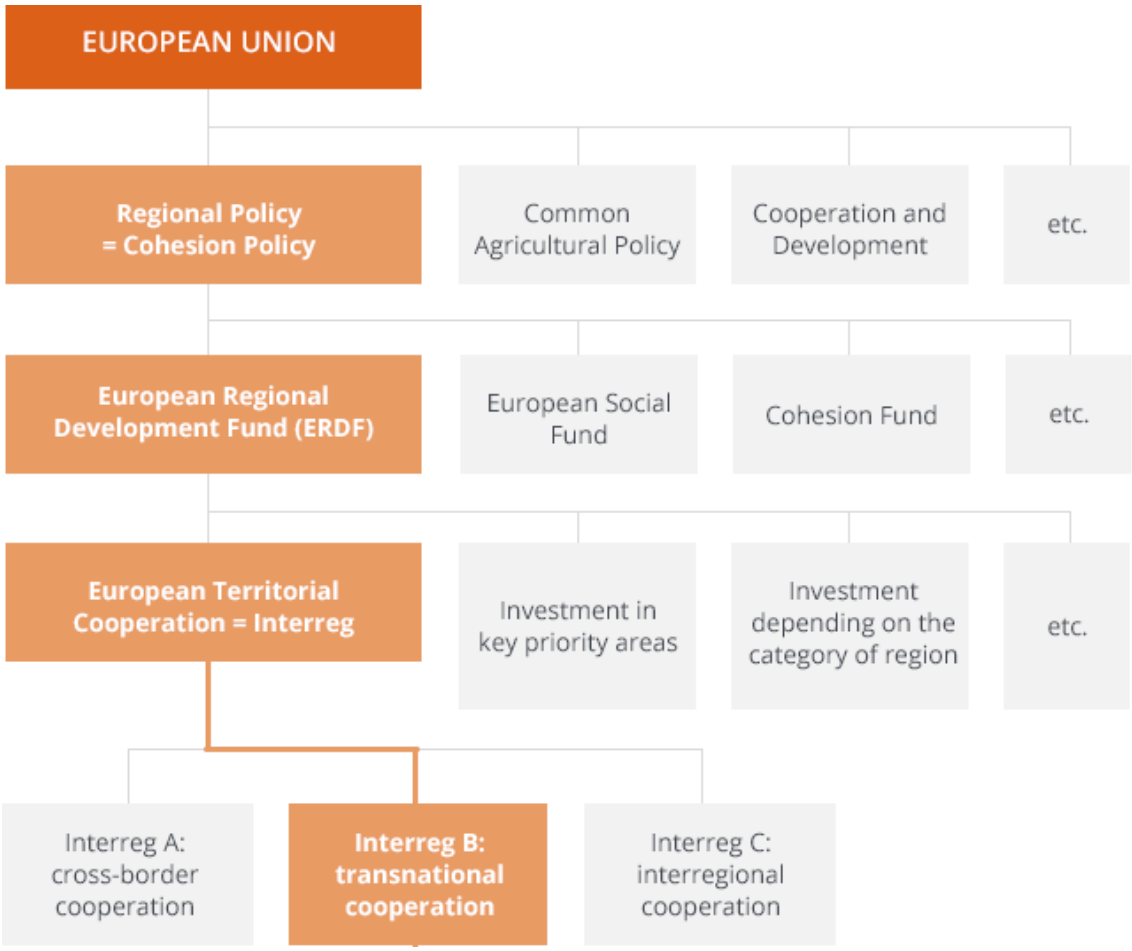


Figure 1.2: Schematic representation of European Territorial cooperation programmes within the European Funding scheme
(source: South West Europe Programme[14]).

Funding for territorial cooperation is provided by the European Regional Development Funds[15], designed to strengthen economic and social cohesion in the EU by correcting imbalances between its regions (EU, 2012 Article 176). The ERDF currently allocates EUR 10.1 billion to territorial cooperation, with this figure representing 2.8% of the total Cohesion Policy budget for 2014–2020. Resources are invested in over 100 cooperation programmes between regions and territorial, social and economic partners. The largest share of the budget is assigned to cross-border cooperation, followed by transnational and interregional cooperation. In more detail, resources are allocated as follows:

- EUR 6.6 billion to 60 cross-border (INTERREG V A) cooperation programmes[16];
- EUR 2.1 billion to 15 transnational (INTERREG V B) cooperation programmes[17];
- EUR 500 million[18] for the interregional cooperation programme (INTERREG V C).

[14] https://www.interreg-sudoe.eu/gbr/programme/about-interreg-sudoe
[15] http://ec.europa.eu/regional_policy/en/funding/erdf/
[16] http://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/cross-border/#2
[17] http://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/trans-national/
[18] http://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/interregional/

In the current programming period (2014–2020), INTERREG also co-finances regional development cooperation programmes outside the EU[19]. These include 12 Instrument for Pre-Accession (IPA) and 16 ENI[20] cross-border collaboration programmes, endowed with EUR 242 million and EUR 634 million respectively.

Box 1.1: INTERACT – Network on Climate change

The INTERACT programme[21] aims to support management authorities of all INTERREG programmes, ENI and IPA Cross border cooperation (CBC) instruments in accomplishing their management tasks and in achieving compliance with EU financing and controlling rules, as well as supporting communication activities. The programme provides, *inter alia*, also content-related support, for instance facilitating cooperation activities of macro-regional and sea basin strategies. Within their support activities for INTERREG programmes, INTERACT is currently building a thematic network among INTERREG programmes addressing climate change and risks (INTERACT Programme, 2017) and is also facilitating exchange among respective thematic coordinators of the EU macro-regional strategies.

The current ERDF regulation identifies 11 funding priorities in three thematic areas (EU, 2013a), as shown in Figure 1.3. The ERDF funding rules impose strong thematic concentration on four of them: research and innovation, information and communication technologies, competitiveness, and low carbon economy. The share of resources to be allocated depends on the category of the region. In developed regions, at least 80% of funds must focus on at least two of the key priorities, while in transition and less developed regions the rate is 60% and 50% respectively. In addition, a variable rate between 12 and 20% of funding must be dedicated to low-carbon economy projects, with lower percentages applying to the less developed regions. These rates are calculated at national and not at programme level (EU, 2013b Article 4).

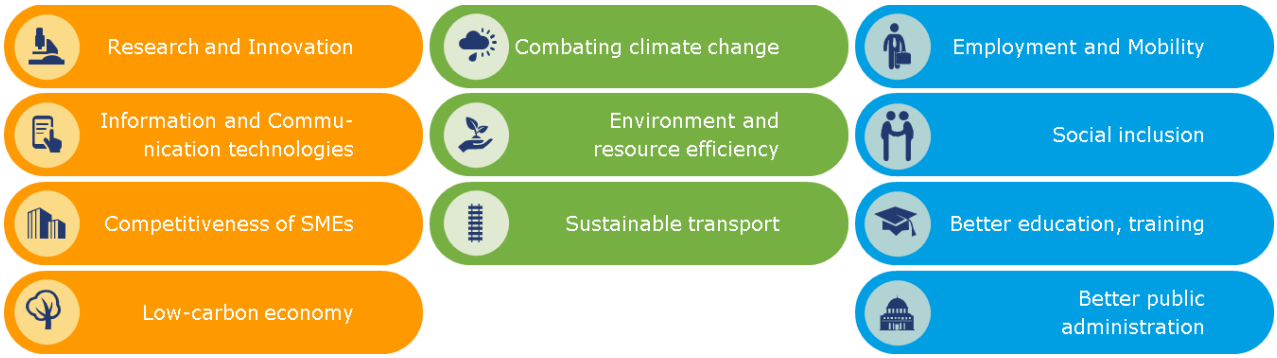


Figure 1.3: Funding priorities of cohesion policies
(source: http://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial)

Figure 1.4 shows a breakdown of the available funding within the INTERREG programmes for priority areas. Combatting climate change and risk prevention currently attract less than 2% of the resources. It

[19] http://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/outside-the-eu/
[20] http://ec.europa.eu/regional_policy/en/policy/cooperation/european-territorial/outside-the-eu/
[21] http://www.interact-eu.net/

needs to be recorded that further to these funding and relative priorities, other programmes such as LIFE and the 'research and innovation' programme Horizon 2020 also contribute to the funding of projects increasing knowledge and capacity for adaptation (see Box 1.2).

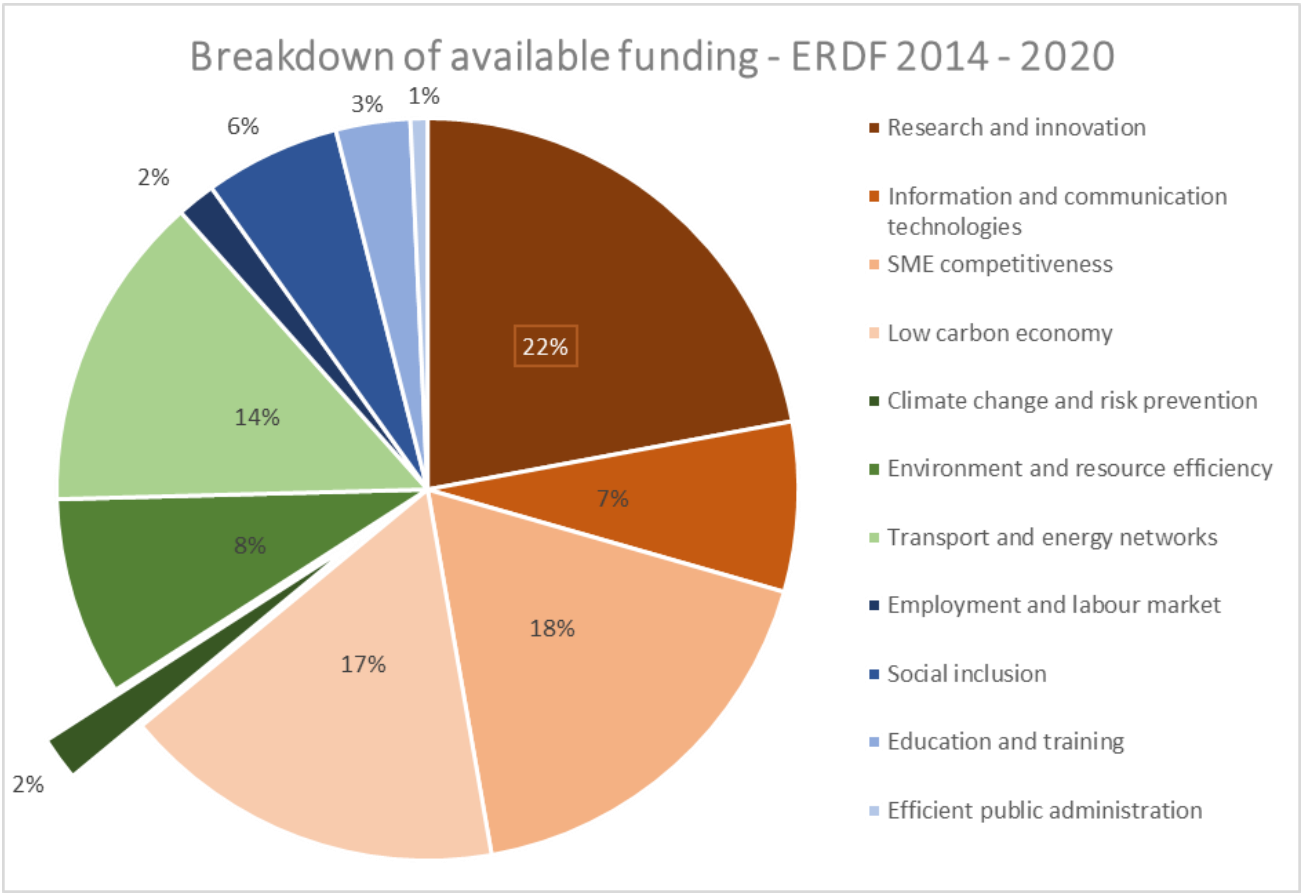


Figure 1.4: Breakdown of funding available in ERDF programmes according to funding priorities *(source: ETC/CCA elaboration based on data from http://ec.europa.eu/regional_policy/en/policy/themes/climate-change; May 2018).*

1.3.2 EU Macro-regional strategies

EU macro-regional strategies[22] are pioneering European policy instruments that foster territorial cohesion through: (1) a better collaboration and multi-level governance arrangement; and (2) a better coordination of the Cohesion Policy with other sectoral policies such as environmental protection, integrated maritime and transport policy. The macro-regions are delineated rather broadly as 'countries or regions associated with one or more common features or challenges' (Katsarova, 2012). They have been designed by the EU since 2005 to translate policy goals into strategies addressing the specific challenges of the macro-region's area.

Currently, four EU macro-regional strategies are in place:

[22] http://ec.europa.eu/regional_policy/it/policy/cooperation/macro-regional-strategies/

- EU Strategy for the Baltic Sea Region – EUSBSR (EC, 2012b);
- EU Strategy for the Danube Region – EUSDR (EC, 2010c);
- EU Strategy for the Adriatic and Ionian Region – EUSAIR (EC, 2014c);
- EU Strategy for the Alpine Region – EUSALP (EC, 2015b).

There is some spatial overlap between the strategies (Figure 1.5). A draft outline for a macro-regional Strategy for the Carpathian Region is currently under discussion (Szuba, 2017), while a macro-regional Strategy for the Atlantic Area was diverted into a maritime strategy, and a macro-regional Strategy for the North Sea region was not further developed due to of a lack of interest by Member States (see Chapter 3).

EU Macro-regional strategies are initiated and requested following 'bottom-up' initiatives by EU Member States in the same geographical area, and are established by a European Council decision, while the European Commission holds a role in coordinating the strategies' delivery. They are pursued through improved cooperation and coordination, without recourse to new legislation, institutions and funding. Rather, they rely on a better use of the resources already available, coordinating and optimising them. Their activities are financed by, *inter alia*, ERDF particularly, but not exclusively, under the stream on transnational cooperation (Gänzle and Kern, 2011). Other sources include the European Union Solidarity Fund (EUSF)[23], European Social Fund (ESF)[24], European Agricultural Fund for Rural Development (EAFRD)[25], European Maritime and Fisheries Fund (EMFF)[26], and in specific cases also IPA[27]. Transnational cooperation is tasked with supporting the development and coordination of macro-regional and sea-basin strategies, with which they often spatially overlap. While the EUSALP area slightly differs from that of the INTERREG Alpine Space Programme, EUSBSR, EUSDR and EUSAIR coincide with the Baltic Sea, Danube and the Adriatic-Ionian transnational regions respectively.

The macro-regions can focus on common regional seas, mountainous or river systems, and represent, as in the case of the Adriatic-Ionian and the Baltic Sea area, important first steps towards the regional implementation of the EU Integrated Marine Policy (Gänzle and Kern, 2011). With respect to climate change adaptation, they present further added value, as regions in geographically similar areas need to address similar challenges and the existence of shared resources typically requires common approaches (Rafaelsen et al., 2017). This is reflected, for instance, in the strategic objectives and actions set out by the EUBSR strategy (sub-objective 3.4), in Priority Area (PA) 5 of the EUSDR strategy (PA5), and in Action 8 of the EUSALP Action Plan (Action 8). The implementation of the EU macro-regional strategies is based on related action plans, which are developed and approved by participating countries and regions as well as the EU. Each priority area defines targets, actions and milestones, which aim to put into practice and prioritise the framework provided by the action plan, also as far as CCA and DRR are concerned.

[23] http://ec.europa.eu/regional_policy/en/funding/solidarity-fund/

[24] http://ec.europa.eu/regional_policy/en/funding/social-fund/

[25] https://ec.europa.eu/agriculture/cap-funding_en

[26] https://echttp://ec.europa.eu/regional_policy/en/funding/ipa/.europa.eu/fisheries/cfp/emff_en

[27] http://ec.europa.eu/regional_policy/en/funding/ipa/

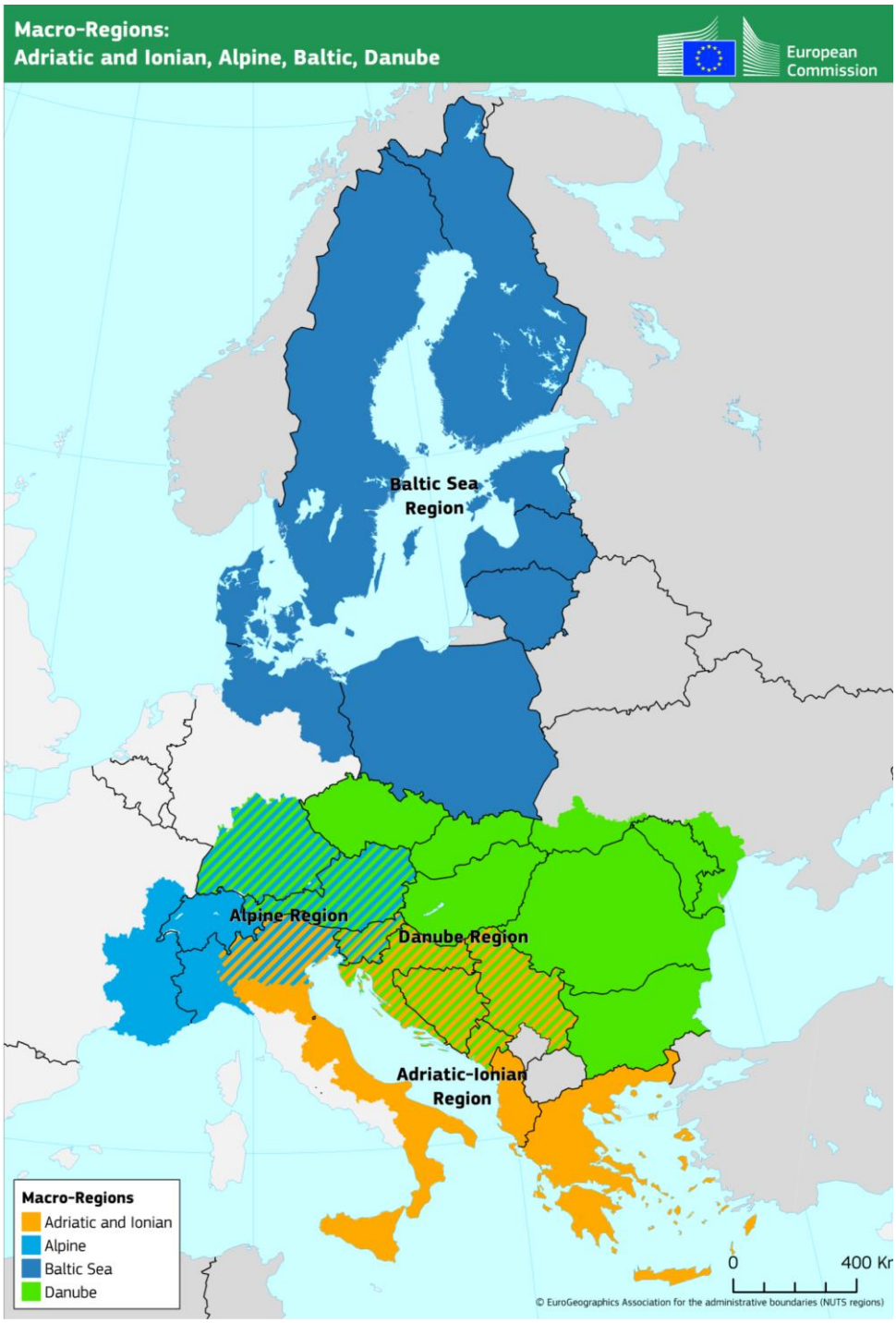


Figure 1.5: EU Macro-Regions
(source: EC, 2016).

Box 1.2: EU LIFE and HORIZON programmes

The EU LIFE programme is identified by the EU Adaptation Strategy (EC, 2013c) as the key funding channel for supporting capacity for adaptation and to step-up adaptation action in Member States (EC, 2013c). EU LIFE programme[28] provides for a dedicated funding scheme on 'Climate Action' (for a budget of EUR 864 million, representing the 25% of the total LIFE programme)[29] to support projects proposing innovative strategies and policies on three priority areas: climate adaptation, mitigation and climate governance, and information. Finance is provided via project action grants, operational support to Non-governmental organizations (NGOs) and new financing instruments (loans and guarantees) aiming at leveraging private finance. Part of these loans, administered by the European Investment Bank (EIB), is explicitly earmarked for adaptation measures based on a natural capital approach. The LIFE Climate Action programme supports both cross-border and transnational projects. For an overview on climate adaptation activities under the EU LIFE programme see the EU LIFE webpage[30] and the Climate-ADAPT page on LIFE. Further to the EU LIFE programme, specific climate related research is also funded under the European research funding programme (Horizon 2020)[31] which aims in particular to close identified knowledge gaps in relation to support for decision-making, costs and benefits of adaption regional and local-level analyses and risk assessments; and an overall improvement of the interface between science, policymaking and business (EC, 2013c Action 4).

[28] http://ec.europa.eu/environment/life/

[29] https://ec.europa.eu/clima/policies/budget/life_en

[30] http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.getProjects&themeID=111

[31] https://ec.europa.eu/programmes/horizon2020/

Box 1.3: Joint Programming Initiatives (JPI)

European research funding plays an important role in supporting transnational cooperation. The JPI Climate[32] co-finances joint research projects addressing knowledge gaps related to climate change and developing common knowledge-bases. The programme has 12 Member countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Norway, Spain, Sweden, The Netherlands, United Kingdom) and five associated countries (Turkey, Denmark, Estonia, Romania, Slovenia), while research partners from Czech Republic, Greece, Portugal and Slovakia participate in research activities in the framework of the 'European Research Area for Climate Services' (ERA4CS). The European Environment Agency (EEA), the European Space Agency (ESA) and the European Climate Research Alliance (ECRA) collaborate as observers. The long-term research strategy for the period 2016–2025 focuses on three thematic areas:

- Understanding the processes and consequences of climate change.
- Improving knowledge on climate-related decision-making processes and measures.
- Researching sustainable societal transformation in the context of climate change.

The second and third areas of investigation are particularly relevant for the design of adaptation policies and strategies (JPI Climate, 2016). An interesting example is provided by the TRANS-ADAPT project, aimed at fostering societal transformation and adaptation to manage dynamics in flood hazard and risk mitigation. This project included case studies in Austria, France, Ireland and the Netherlands[33].

[32] http://www.jpi-climate.eu/programme/about-JPI-Climate

[33] http://www.jpi-climate.eu/2013projects/transadapt

1.4 The INTERREG transnational regions

Transnational regions are generally defined according to shared natural systems (e.g. sea basins, sub-sea basin, river basins, mountain areas etc.) or territorial, socio-economic and climatic commonalities. This section provides a brief description of the 12 transnational cooperation areas, highlighting their geographical scope, and the main challenges and opportunities addressed.

1.4.1 Northern Periphery and Arctic

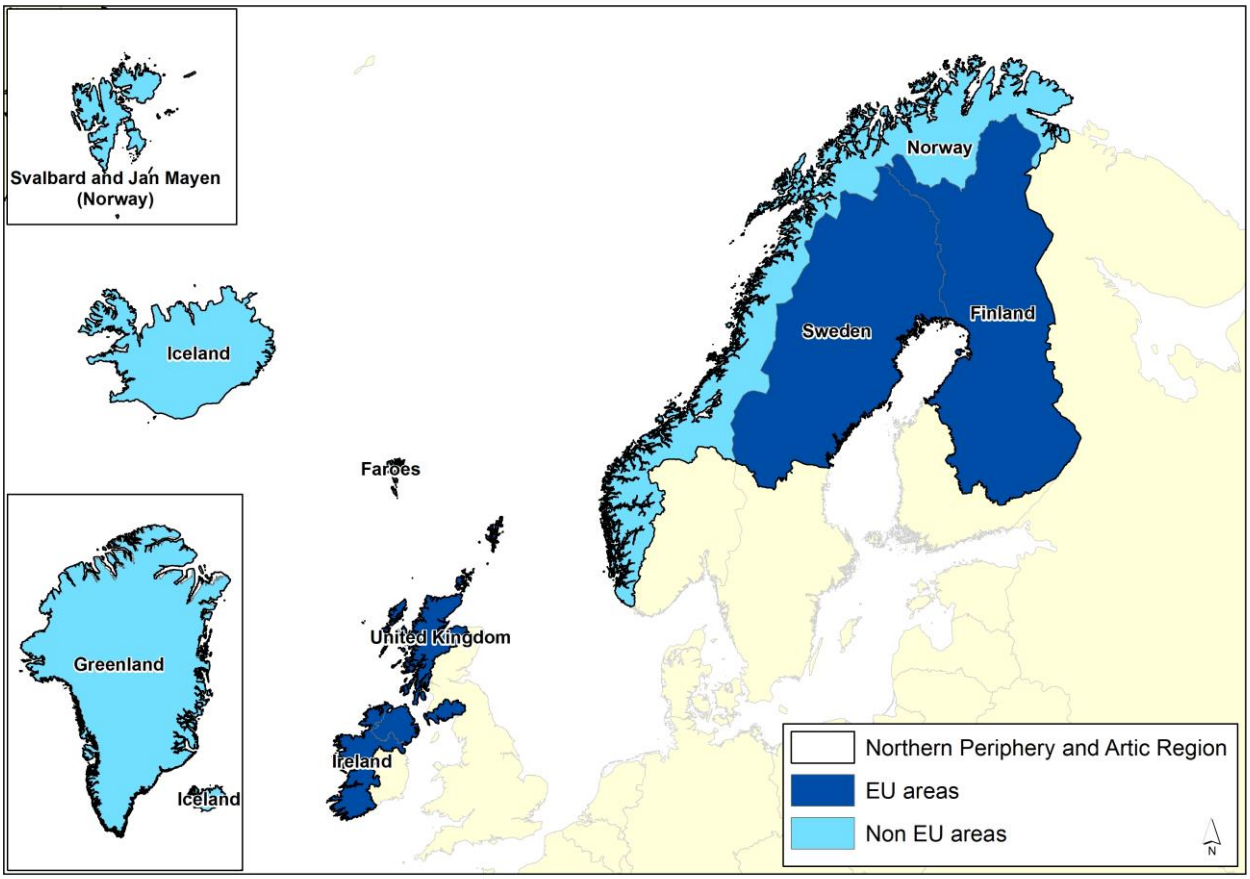


Figure 1.6: Cooperation area of the INTERREG V B Northern Periphery and Arctic Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG NPA, 2016).

The INTERREG V B Northern Periphery and Arctic (NPA) Programme comprises the Euro-Arctic zone, including parts of the Atlantic zone and parts of the Barents region. It covers partly or entirely four EU Member States (northern part of Finland, Ireland, Sweden, and Scotland and Northern Ireland in the United Kingdom) as well as the Faroe Islands, Iceland, Greenland and coastal areas of Norway. Further to addressing the challenges represented by the peripheral character of the area, the Arctic dimension has been underlined in the programme title following a request of the European Commission. This is meant to reflect the growing international and EU interest in developments in the Arctic area, mainly driven by climate change and the new challenges and opportunities that it brings (INTERREG NPA, 2016, p. 6).

Together with the Atlantic Area and the North Sea, this region is part of the area covered by the OSPAR Convention (see Box 1.4). The area of the Northern Periphery and Arctic corresponds to the OSPAR sub region 'Arctic Waters'.

Box 1.4: OSPAR Convention

The OSPAR convention builds on two prior international conventions (the Oslo and the Paris conventions from 1974 and 1978 respectively) addressing the prevention of marine pollution. It was signed in 1992, with Luxembourg, Switzerland and the EU communities as additional signatories to those who had already signed the two previous conventions (Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom). The area of the OSPAR Convention covers the wider area of the Atlantic Sea and is subdivided into five sub-regions which correspond to some of the transnational regions: Arctic Waters, Greater North Sea, Celtic Seas, Bay of Biscay and Iberian Coast, and Wider Atlantic.

1.4.2 Atlantic Area

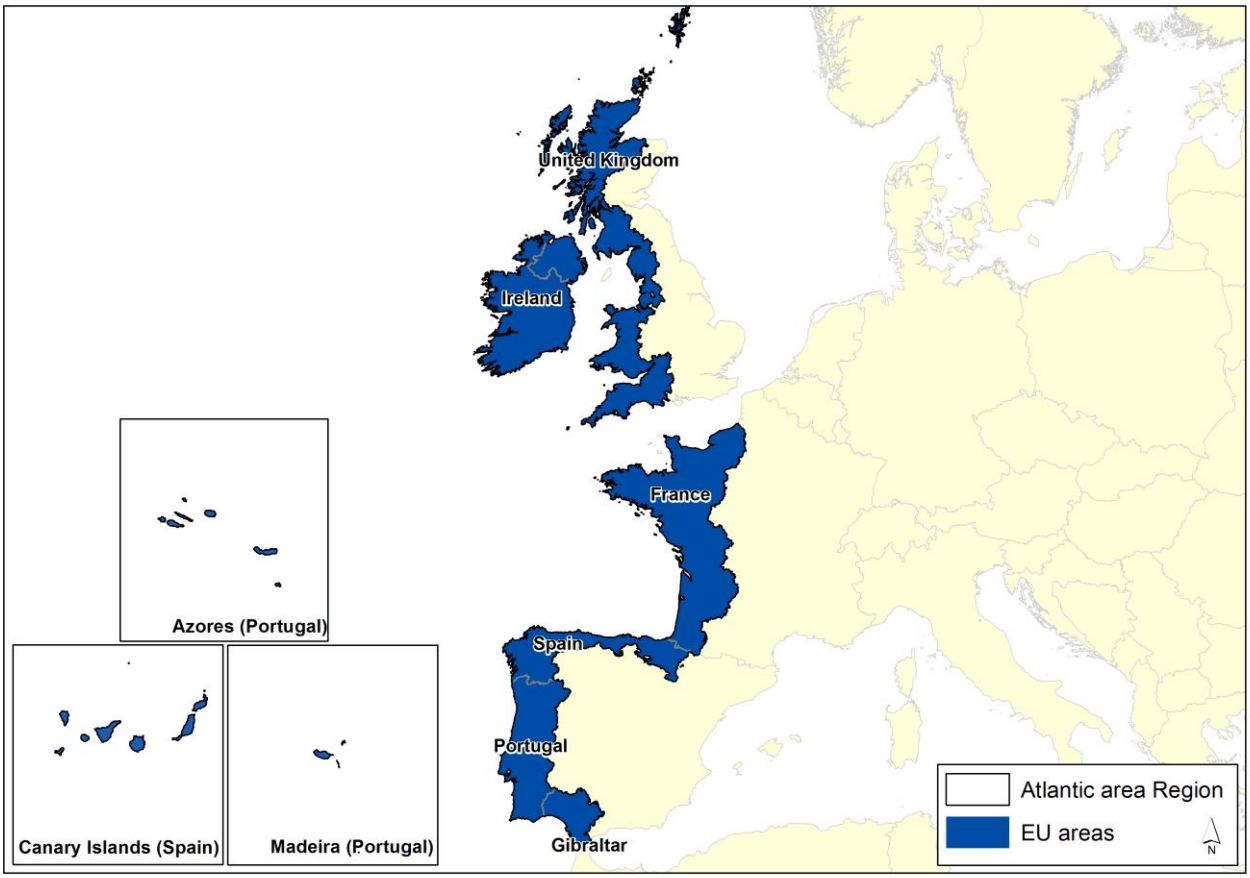


Figure 1.7: Cooperation area of the INTERREG V B Atlantic Area Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG Atlantic Area, 2018)

The INTERREG V B Atlantic Area Programme[34] includes the 38 Atlantic coastal regions of Portugal, Spain, France, the United Kingdom and Ireland and, since the most recent programming period (2014–2020), comprises the autonomous regions of Madeira and Azores in Portugal and the autonomous community of Canary Islands in Spain. Consisting mainly of coastal areas, the area is exposed to sea level rise and an

[34] http://www.atlanticarea.eu/

increase in negative impacts from industrial and transport generated pollution (INTERREG Atlantic Area, 2018). Together with the regions of Northern Periphery and Arctic, and North Sea, this region is covered by the OSPAR Convention (see Box 1.4), and includes, in particular, two sub-regions of the convention: the Celtic Seas and the Bay of Biscay and Iberian Coast.

1.4.3 North West Europe

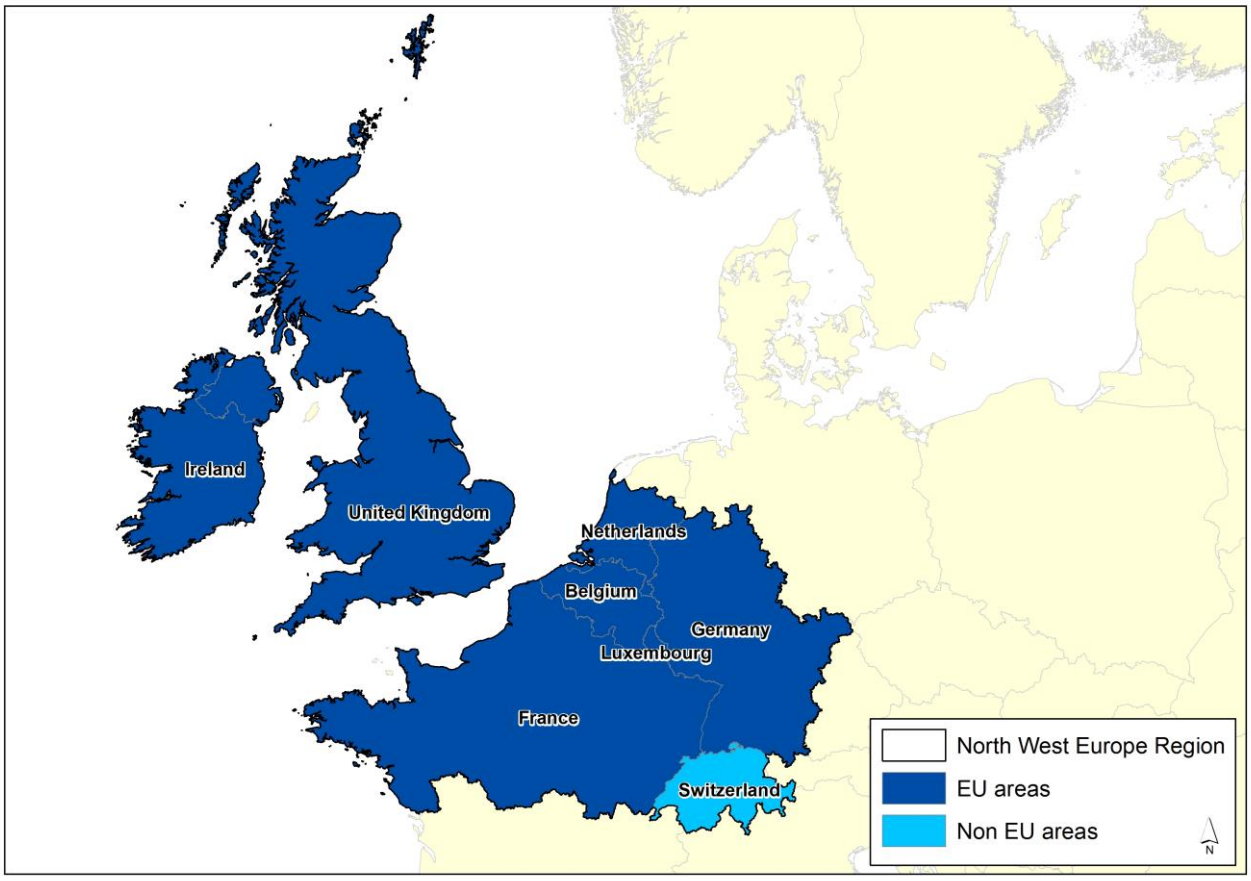


Figure 1.8: Cooperation area of the INTERREG V B North West Europe Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG NWE, 2015)

The INTERREG V B North West Europe (NWE) Programme involves Ireland, the United Kingdom, Belgium, Luxembourg, Switzerland, and parts of France, Germany and the Netherlands. While the region is considered one of the most dynamic and prosperous areas of Europe, it also faces many environmental, social and economic needs and challenges. The area is characterised by a high density of infrastructure and built environment in urban areas which are often located near coasts and rivers (INTERREG NWE, 2015).

Together with other regions, North West Europe is covered by the OSPAR Convention (see Box 1.4); in particular the western parts of its coasts are covered by the OSPAR Celtic Seas sub region.

1.4.4 North Sea

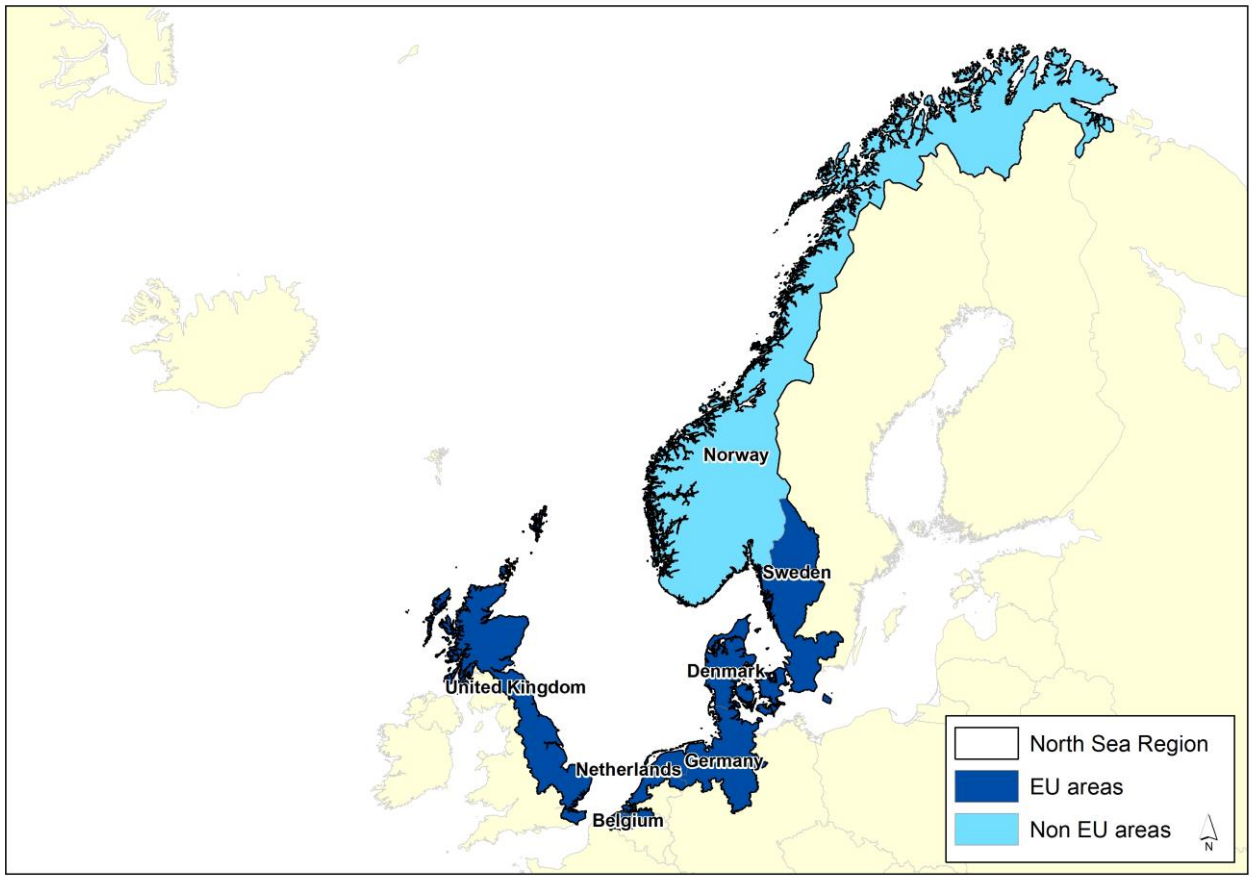


Figure 1.9: Cooperation area of the INTERREG V B North Sea Programme
(source: our elaboration based on EuroGeographics, 2015; INTERREG NSR, 2015a)

The INTERREG V B North Sea (NSR) Programme covers the coastal areas around the North Sea basin, that includes the entire territory of Denmark, the eastern parts of the United Kingdom, three provinces of the Flemish region of Belgium, the north-western regions of Germany, the northern and western parts of the Netherlands and the south-western area of Sweden, in addition to the entire territory of Norway as a non-EU partner. The programme area covers a heterogeneous territory, ranging from the less inhabited areas of Europe such as the northern Norwegian areas to densely populated urban areas such as the Dutch and Belgian coastal areas in the south-east (INTERREG NSR, 2015a).

Together with the regions of Northern Periphery and Arctic, and Atlantic Area, this region is part of the area covered by the OSPAR Convention (see Box 1.4) and specifically corresponds to the area covered by the OSPAR North Sea sub-region.

1.4.5 Baltic Sea

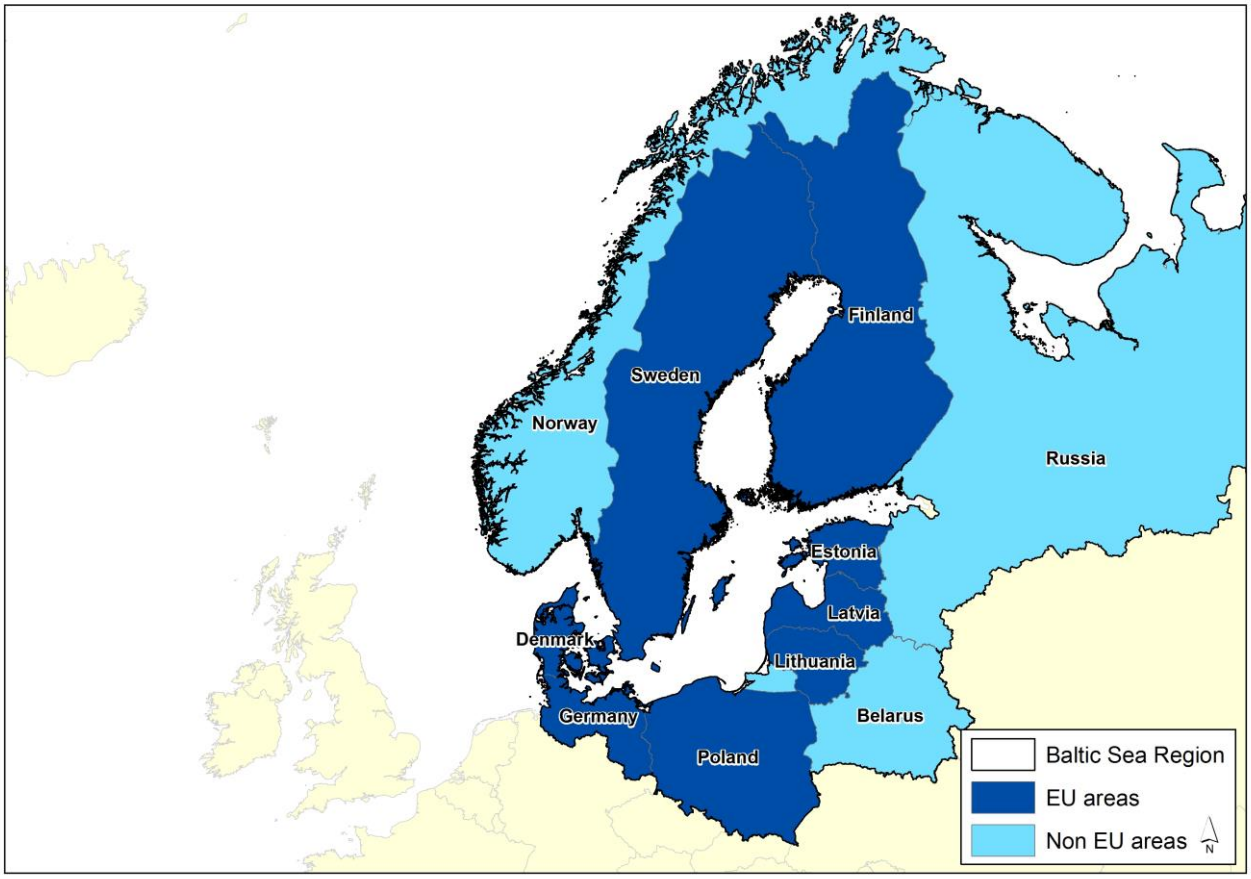


Figure 1.10: Cooperation area of the INTERREG V B Baltic Sea Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG BSR, 2015)

The INTERREG V B Baltic Sea (BSR) Programme covers eleven countries, eight EU Member States bordering the Baltic Sea (Sweden, Finland, Estonia, Latvia, Lithuania, Poland, Germany and Denmark) and three partner countries (Belarus, Norway and the north-western regions of Russia). It stretches from central Germany up to the northern peripheral areas of Sweden and Finland, Norway and Russia, including the urban areas of Berlin, Copenhagen, Helsinki, Oslo, Stockholm, Warsaw and St. Petersburg, as well as the Arctic coastal areas of Norway and Russia.

The EU Strategy for the Baltic Sea Region, defined in 2012 (EC, 2012b), was the first comprehensive EU strategy to target a macro-region in Europe[35]. It aims to reinforce cooperation within the Baltic Sea region to promote more balanced development in the area, to contribute to major EU policies and to reinforce integration.

The region's countries are, except for Norway and Belarus, also contracting parties of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, also known as the Helsinki Convention, (HELCOM, 1992) (see section 3.5 for further detail).

[35] https://www.balticsea-region-strategy.eu

1.4.6 Alpine Space

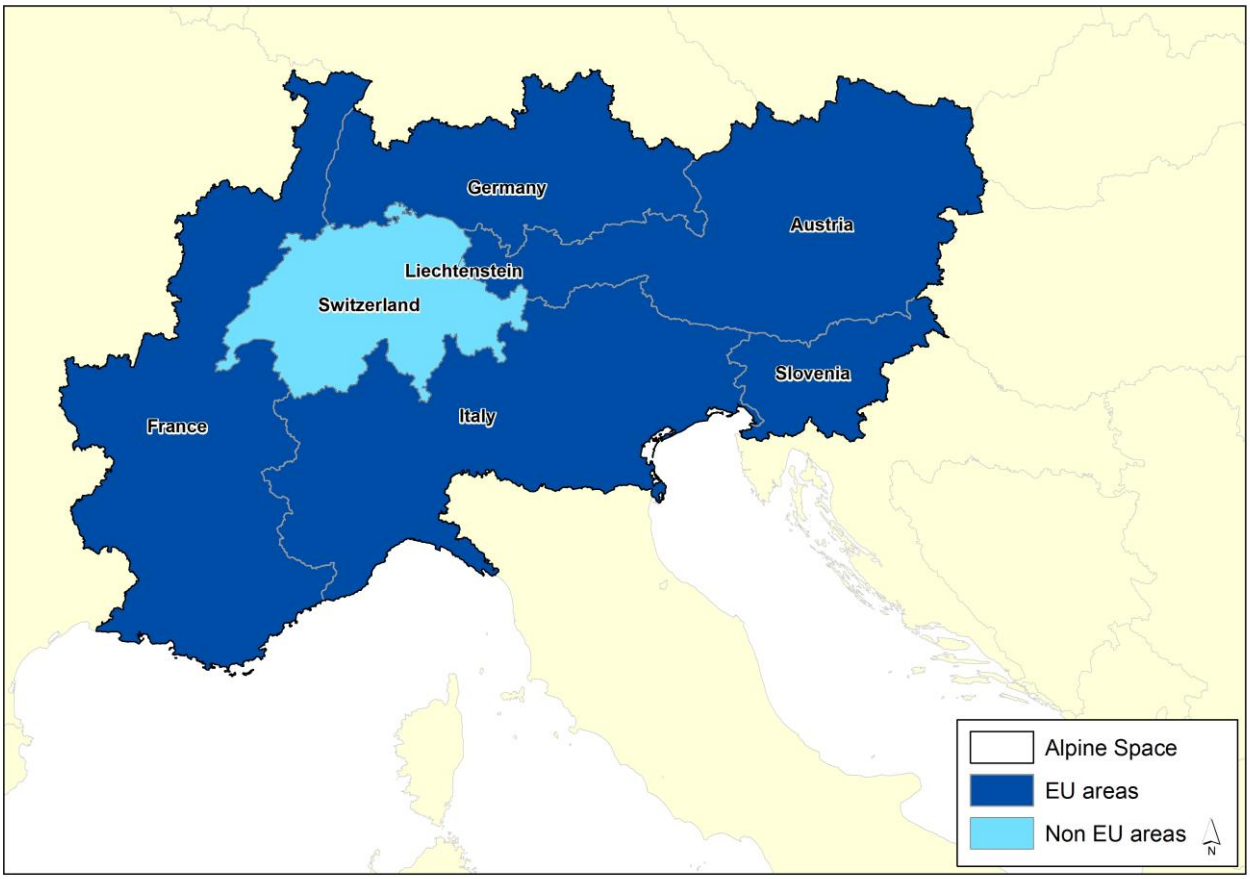


Figure 1.11: Cooperation area of the INTERREG V B Alpine Space Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; Alpine Space 2014–2020, 2015)

The INTERREG V B Alpine Space Programme (ASP) covers the Alps and their surrounding lowlands, including: the entire territory of Switzerland, Austria, Liechtenstein and Slovenia, the French Alps and the Rhone Valley (parts of the Auvergne-Rhône-Alpes Region, the Bourgogne-Franche-Comté and the Grand Est Regions and the Region Provence-Alpes-Côte d'Azur), the southern regions of Germany (Oberbayern, Schwaben, Tübingen and Freiburg), and the Alpine foothills regions of Italy (the regions of Friuli Venezia Giulia, Liguria, Lombardia, Piemonte, Valle d'Aosta, and Veneto, and the autonomous Provinces Bolzano/Bozen and Trento). In addition to mountain areas, it embraces metropoles such as Lyon, Milan and Munich.

The Alpine Convention was signed in 1991 and commits the eight Alpine countries (Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland) and the European Union to the sustainable development and protection of the Alpine massif.

Since 2015, the Alps and their periphery have also been covered by the EU Strategy for the Alpine Region (EC, 2015a) which involves seven countries (all Alpine countries except Monaco) and 48 regions, mostly overlapping with the Alpine Space Programme except in the northernmost areas. These three Alpine transnational entities cover different Alpine areas (see Figure 1.12).

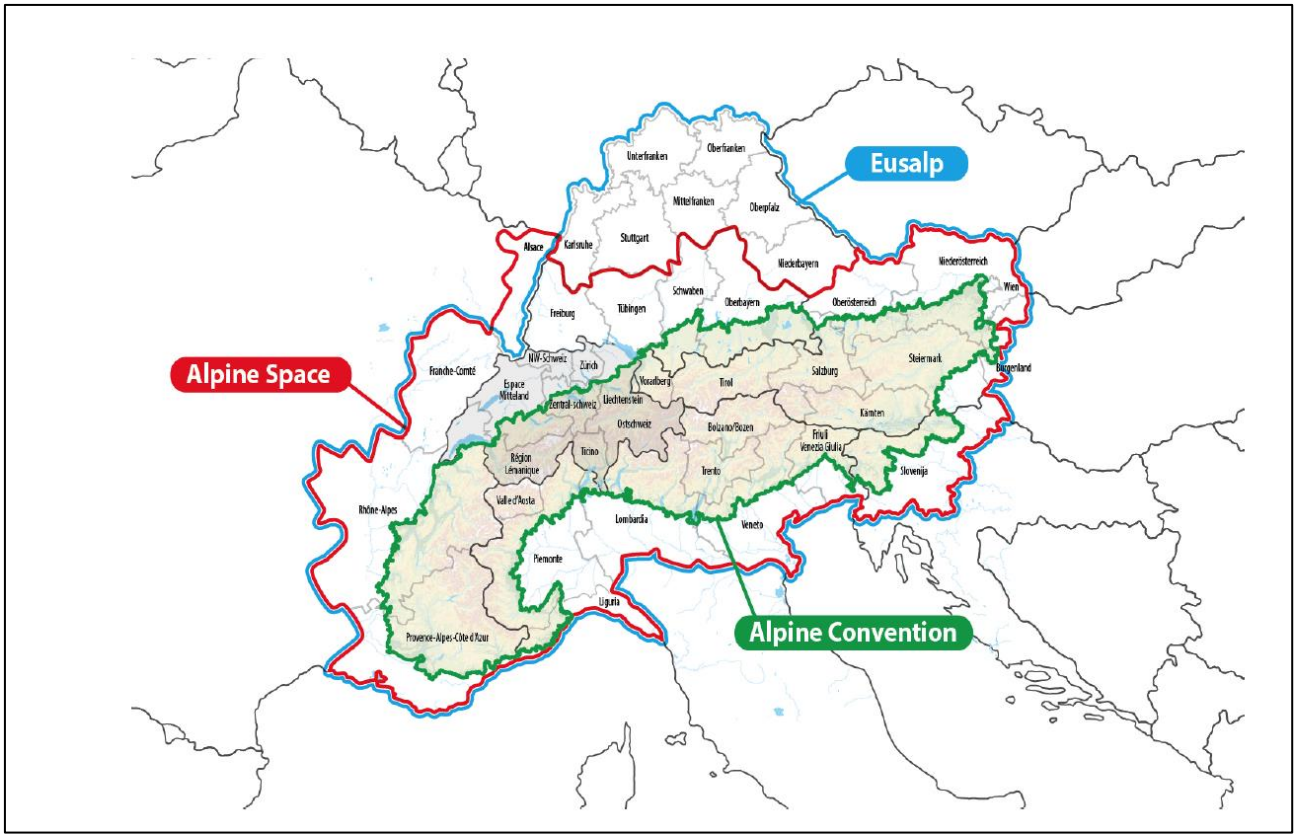


Figure 1.12: Comparison among perimeters of EUSALP, Alpine Space Programme and Alpine Convention

(source: http://ec.europa.eu/regional_policy/en/information/publications/maps/2015/comparison-perimeter-eusalp-alpine-space-programme-alpine-convention)

1.4.7 Central Europe

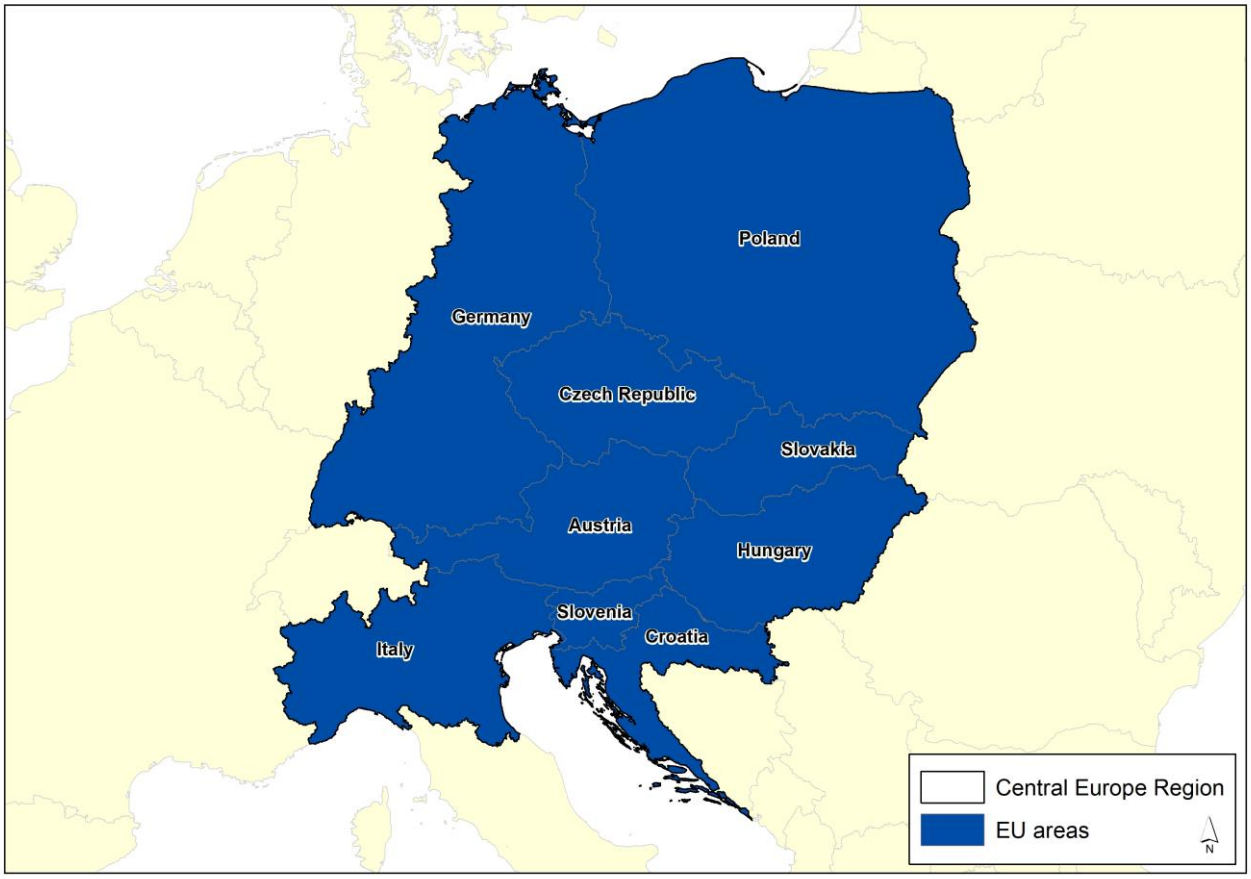


Figure 1.13: Cooperation area of the INTERREG V B Central Europe Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG Central Europe, 2016).

The INTERREG V B Central Europe Programme includes large regions on both sides of the line that formerly designed the 'Iron Curtain' between eastern and western Europe. It covers an area which reaches from the southern borders of the Baltic sea to the northern Adriatic and the Ligurian seas, including the entire area of seven EU Member States (Austria, Croatia, the Czech Republic, Hungary, Poland, Slovakia and Slovenia), as well as central and eastern regions of Germany and the northern regions of Italy. The programme area is highly heterogeneous in geographical (including coastal areas, mountain ranges, rural areas, large urban agglomerations, etc.) as well as in economic and social terms, with a still visible east-west division (INTERREG Central Europe, 2016).

Further to the Danube River Protection Convention covering most of the area of this region, it is furthermore covered by the Carpathian Convention (see section 3.8) and the Alpine Convention (see section 3.6). Moreover, the northern part (Germany and Poland) is also covered by the HELCOM Convention (see section 3.5), while its southern part (Italy, Slovenia and Croatia) is covered by the Barcelona Convention (see section 3.9).

1.4.8 Danube

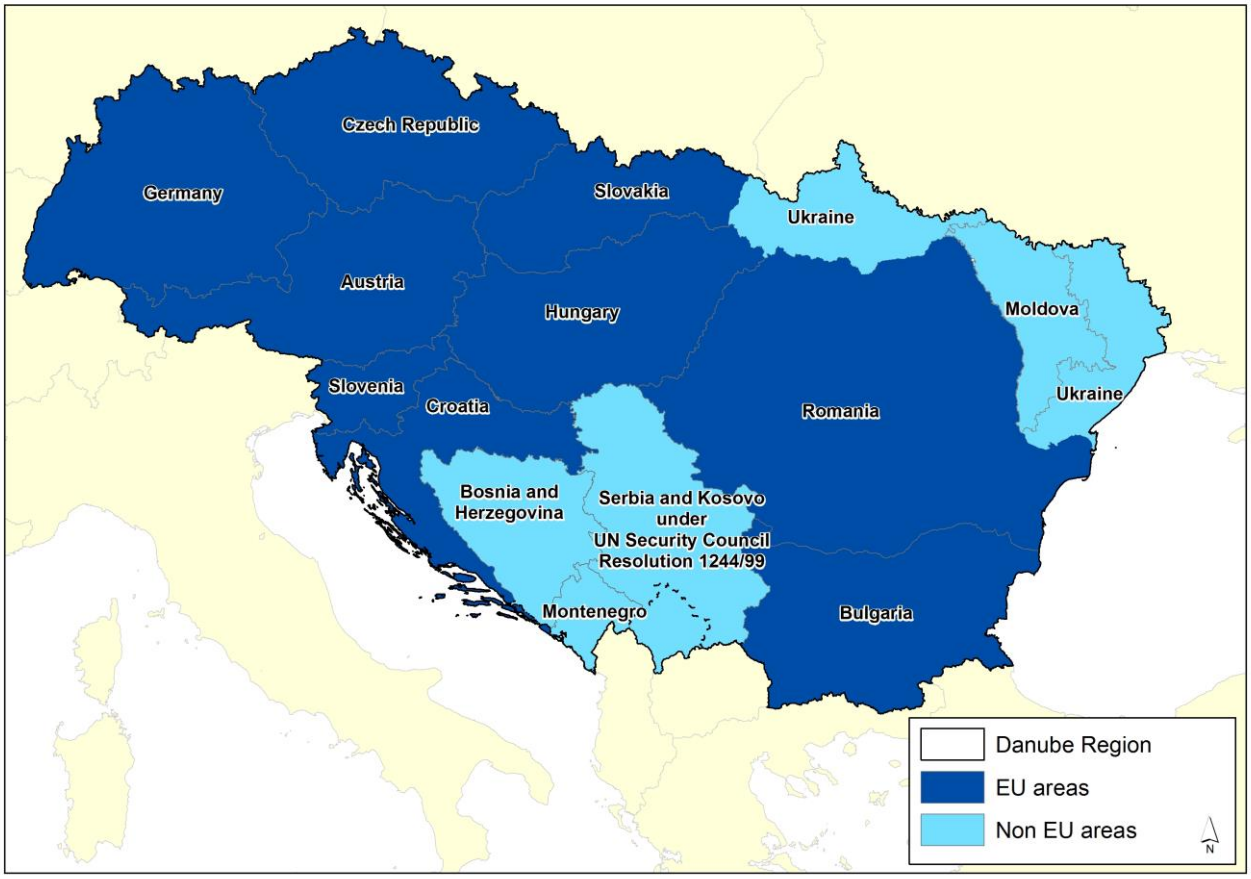


Figure 1.14: Cooperation area of the INTERREG V B Danube Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG Danube, 2017).

The INTERREG V B Danube Programme (DTP) covers the Danube river basin, which is the largest in Europe and stretches from the Alps and the Carpathian to the river plain and its mouth on the Black Sea. It involves partly or entirely nine EU Member States (Austria, Bulgaria, Croatia, the Czech Republic, the south-eastern Länder of Baden-Württemberg and Bavaria in Germany, Hungary, Romania, Slovakia, Slovenia) alongside 5 non-EU Member States (Bosnia and Herzegovina, the Republic of Moldova, Montenegro, Serbia, and four provinces of Ukraine) and has the same geographical scope as the EU Strategy for the Danube Region (EUSDR).

The area of the Carpathian Convention is mainly included in this region (see Figure 1.15). The Convention for the Carpathian Mountains was signed in May 2003 by seven Carpathian States (Czech Republic, Hungary, Poland, Romania, Serbia, Slovak Republic, and Ukraine) and came into force in 2006. It aims to improve the sustainable development and protection of this mountain region. Within this cooperation framework, the Strategic Agenda on Adaptation to Climate Change in the Carpathian Region was adopted in 2014.

The second international convention which covers parts of the region is the Danube River Protection Convention (ICPDR, 1994), the overall legal instrument for cooperation on transboundary water management in the Danube River Basin. It was signed in 1994 by 11 of the Danube riparian states – Austria, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Moldova, Romania, Slovakia, Slovenia

and Ukraine – and the European Community, and came into force in 1998. Its main objective is to ensure that surface waters and groundwater within the Danube River Basin are managed and used sustainably and equitably.

The Danube region is the one of the few transnational region to also share the Black Sea coast (INTERREG Danube, 2017). Its common geographic feature is represented by the Danube river basin which has been the subject of a long-term common policy efforts for transnational river basin management. As a consequence, this is also the only transnational region covered by the Convention for the Protection of the Black Sea Against Pollution (Bucharest Convention, 1994)[36] with Romania, Bulgaria and Ukraine as contracting parties. At its southern and western part, the region is also included as part of the Alpine Convention (with Austria and Slovenia being contracting parties, see section 3.6) and of the Barcelona Convention with Slovenia, Croatia, Bosnia and Herzegovina and Montenegro being contracting parties (see section 3.9).

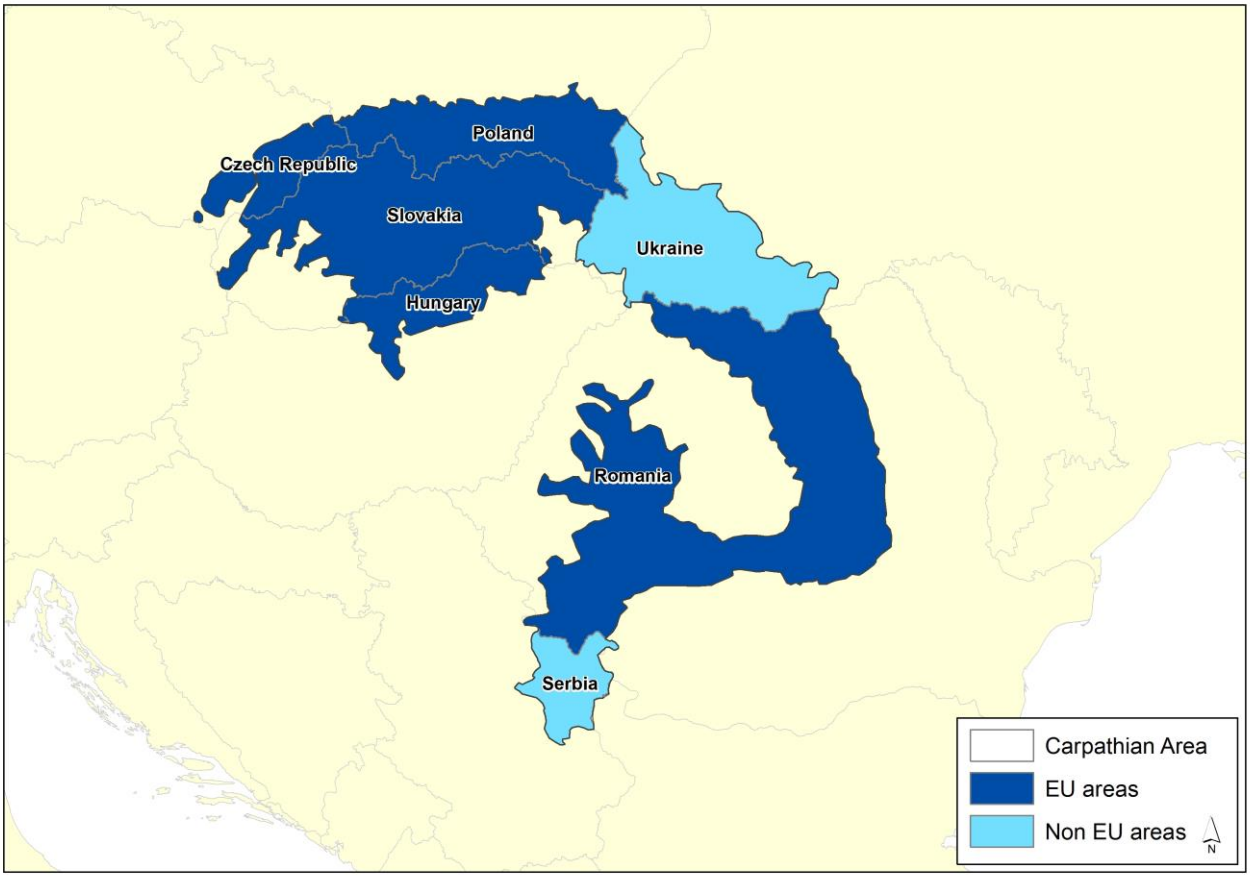


Figure 1.15: Carpathian area
(source: ETC/CCA elaboration based on EuroGeographics, 2015; UNEP, 2007).

[36] http://www.blacksea-commission.org/_convention.asp

1.4.9 Mediterranean

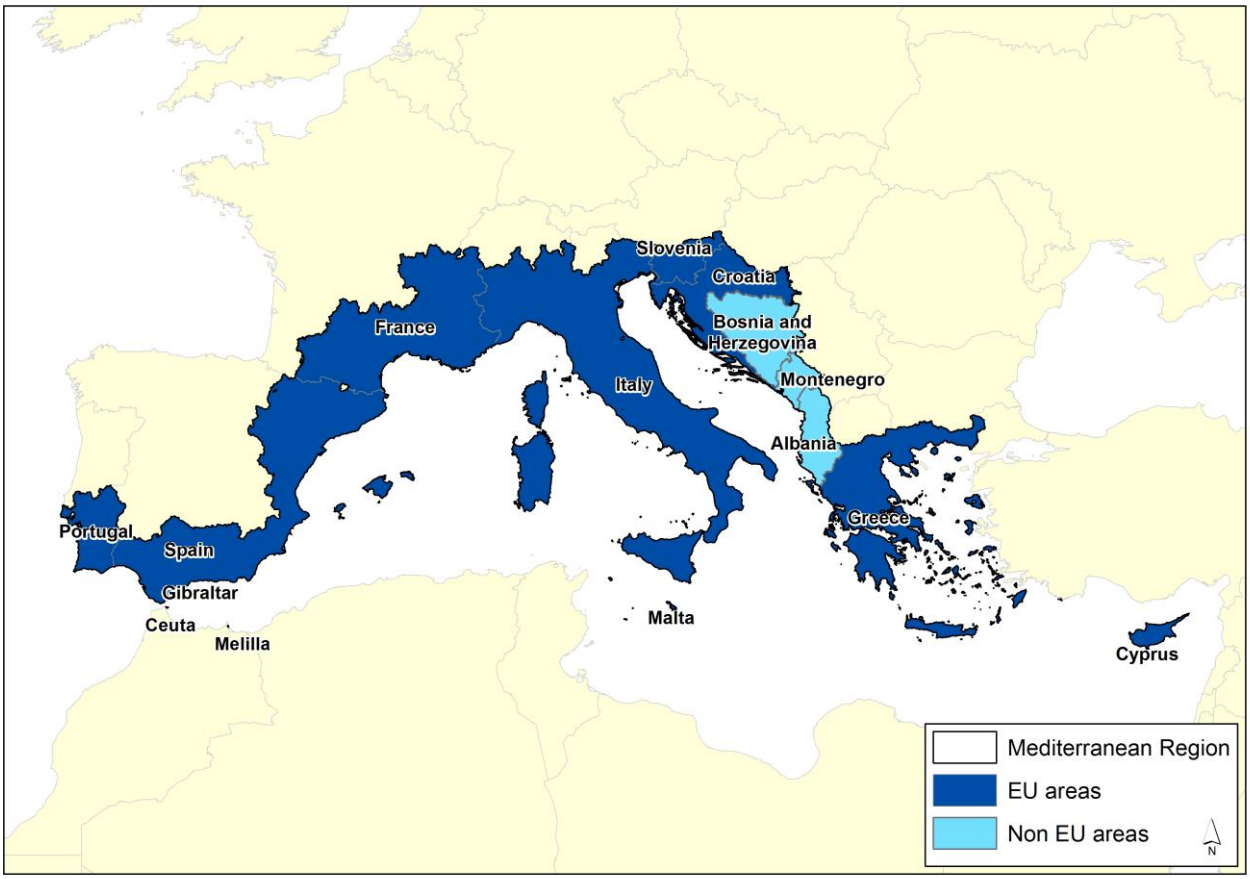


Figure 1.16: Cooperation area of the INTERREG V B Mediterranean Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG Mediterranean, 2016).

The INTERREG V B Mediterranean (MED) Programme includes 10 EU Member States and regions facing the Mediterranean basin (southern part of Portugal, Mediterranean areas of Spain and France, almost the whole of Italy and the entire area of Slovenia, Croatia, Greece, Malta and Cyprus, and the United Kingdom (UK) territory of Gibraltar) and three candidate EU countries (Albania, Bosnia-Herzegovina and Montenegro) benefitting from IPA. Since the previous programming period, the area has been slightly enhanced, and now includes Lisbon (Portugal) as a third Portuguese region, Midi-Pyrénées (as a further French region), and Valle d'Aosta (Italy), (INTERREG Mediterranean, 2016).

It includes the European parts of the territory covered by the Barcelona convention (1995) and the United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP)[37] (UNEP/MAP, 2016b)(UNEP/MAP, 2016b). The Barcelona Convention with its several protocols covers the area of the whole Mediterranean, hence it includes: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syrian Arab Republic, Tunisia, Turkey, and the European Union.

[37] http://web.unep.org/unepmap/action-plans

The area has some overlaps with the Alpine Convention (see section 3.6) for the south-western coasts of France, the northern coasts of Italy and for Slovenia. In addition, the Balkan countries are covered by the Convention for the Protection of the Danube River (see section 3.8).

1.4.10 South West Europe

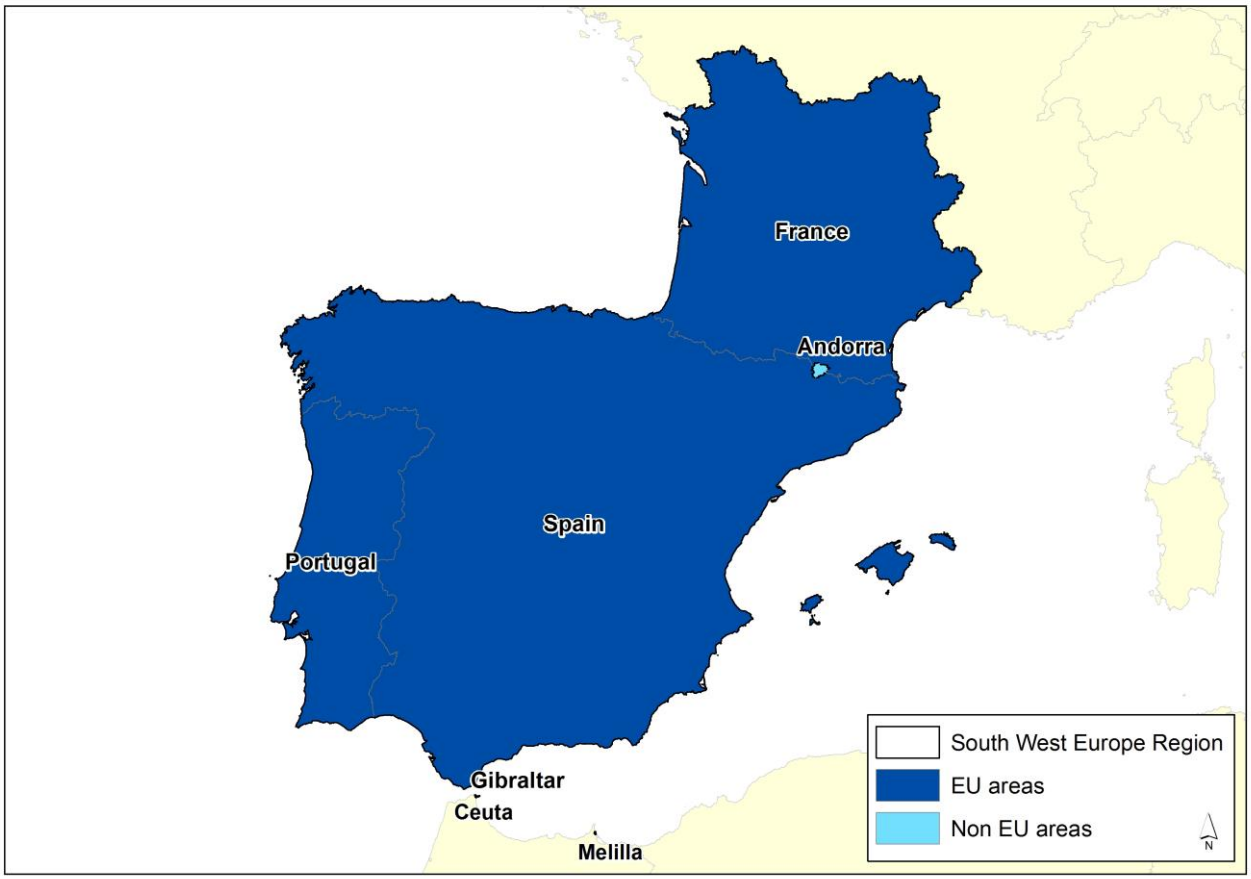


Figure 1.17: Cooperation area of the INTERREG V B South West Europe Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG SUDOE, 2017).

The INTERREG V B South West Europe Programme (SUDOE) covers the southern regions of France (Auvergne, Nouvelle Aquitaine, Occitanie), the entire territory of Spain (including the Balearic Islands and the territories of Melilla and Ceuta), Portugal, and the UK territory of Gibraltar in addition to the Principality of Andorra as a non-EU partner. The Atlantic islands of Portugal (Azores) and Spain (Canary Islands) are not part of this programme.

The region includes the Pyrenees mountain area (see Figure 1.18). Since 1980, the Pyrenean mountain range holds a cross-border cooperation entity called Working Community of the Pyrenees (CTP). Since 2010, this entity has sought to strengthen cross-border cooperation on adaptation through the Pyrenean Climate Change Observatory (OPCC) (see sections 3.10 and 4.2 for more information).

Countries of this region are part of the Barcelona Convention (Spain and France, see section 3.9) and of the OSPAR Convention (Portugal, Spain and France, see section 3.2 and Box 1.4).

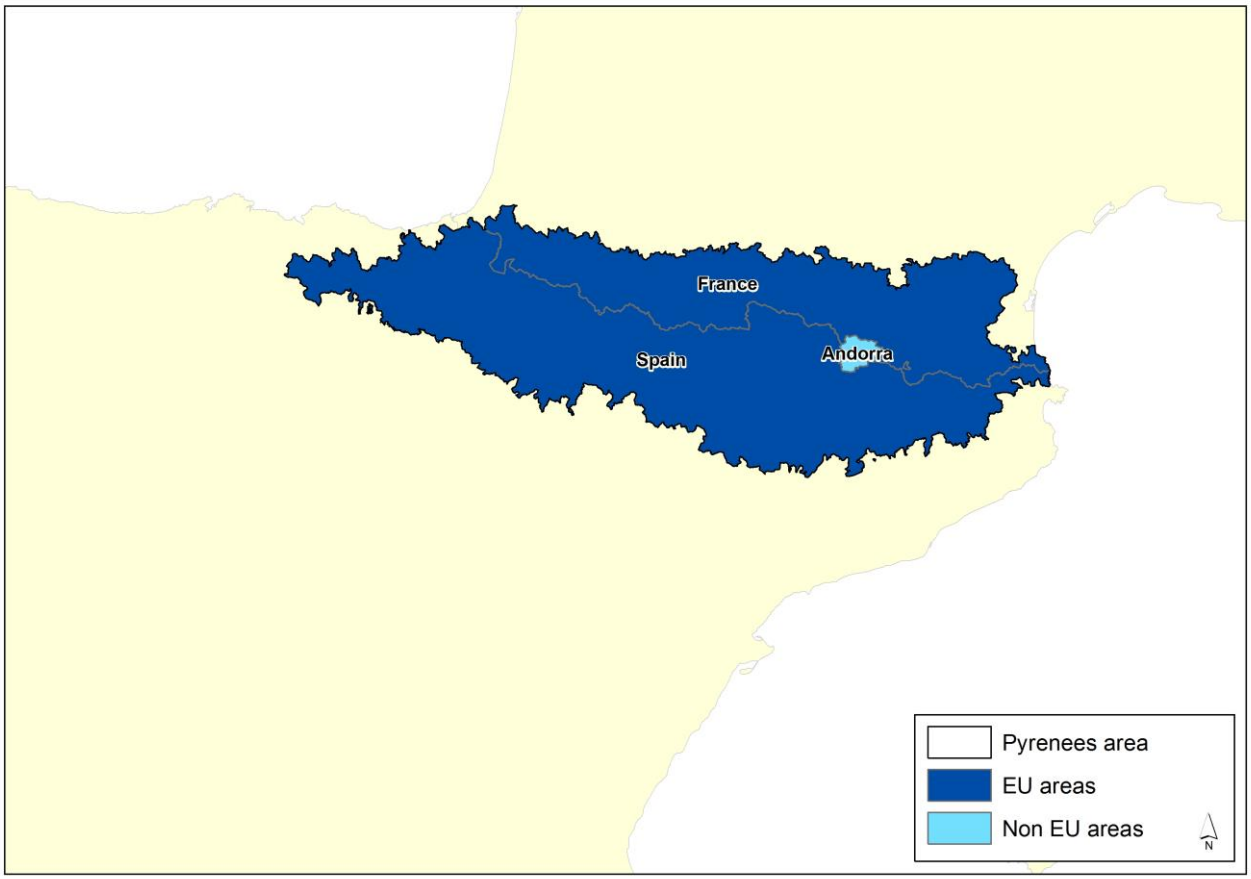


Figure 1.18: Pyrenees area
(source: ETC/CCA elaboration based on data from Working Community of the Pyrenees (CTP)).

1.4.11 Adriatic-Ionian

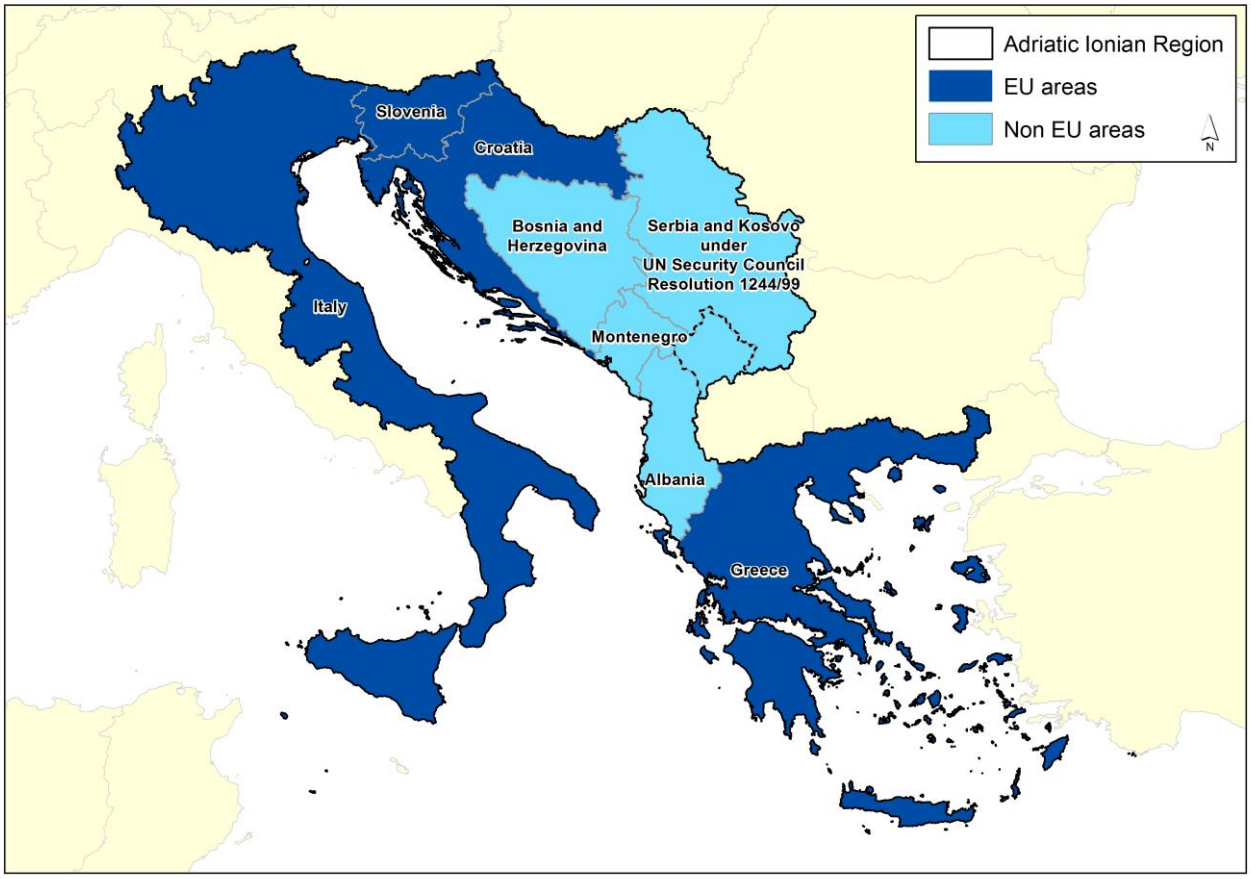


Figure 1.19: Cooperation area of the INTERREG V B Adriatic-Ionian Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG ADRION, 2015).

Together with the Balkan-Mediterranean and Danube programmes, the INTERREG V B Adriatic-Ionian Programme (ADRION) is one of the three new programmes which succeed the previous INTERREG South East Europe (SEE) 2007–2013. In the previous programming period part of the current ADRION cooperation area was also included in the Adriatic IPA Cross-Border Cooperation Programme. ADRION covers the entire extension of the EU Member States of Greece, Croatia and Slovenia, as well as 12 Italian regions (Abruzzo, Molise, Puglia, Basilicata, Calabria, Sicilia, Provincia Autonoma di Trento, Provincia Autonoma di Bolzano/Bozen, Veneto, Friuli-Venezia Giulia, Lombardia, Emilia-Romagna, Umbria and Marche) and in addition includes the four IPA Partner States of Albania, Montenegro, Serbia, Bosnia and Herzegovina. The area coincides with the region of EUSAIR (EC, 2014c).

As well as the area of the Barcelona Convention (see section 3.9), in which all countries with exception of Serbia participate, the area is covered by the Danube River Protection Convention (see section 3.8).

1.4.12 Balkan-Mediterranean

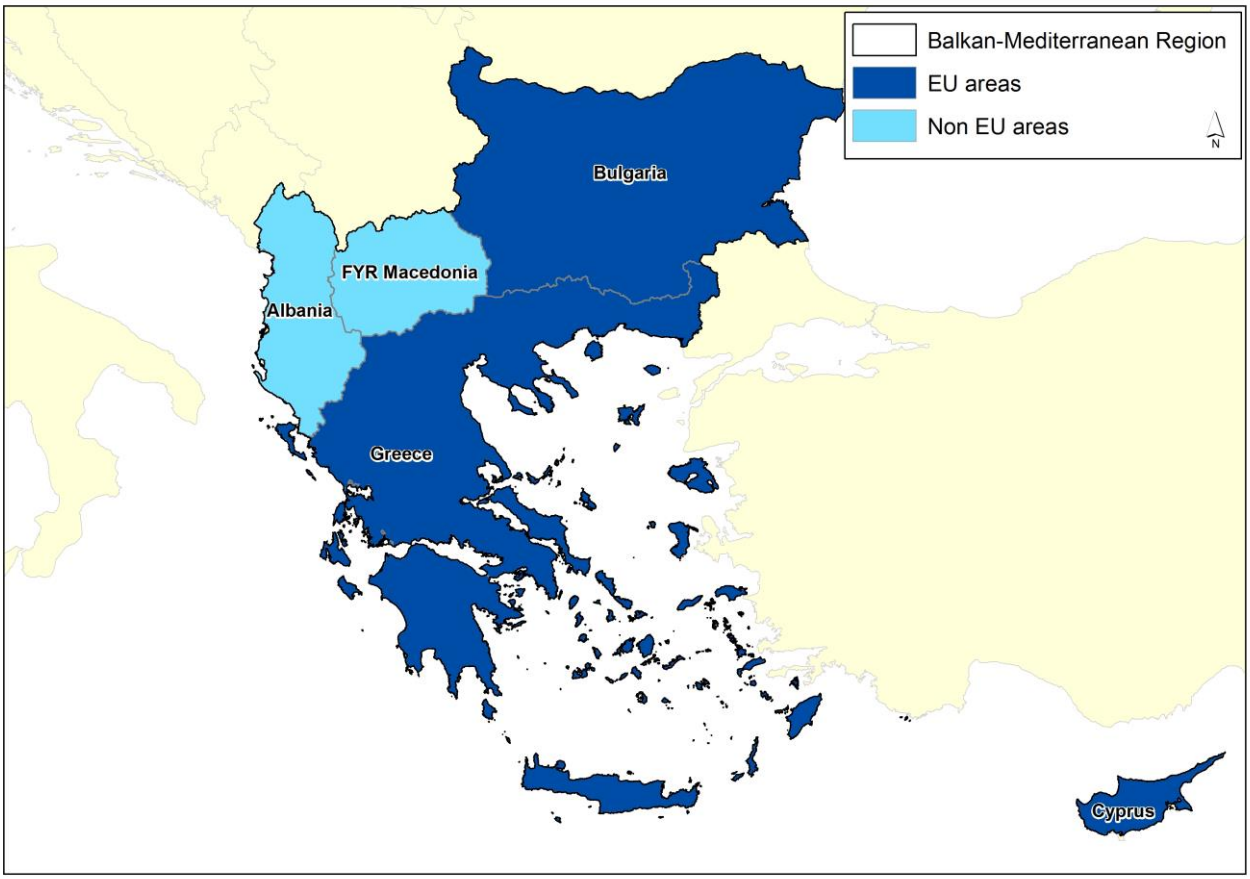


Figure 1.20: Cooperation area of the INTERREG V B Balkan-Mediterranean Programme
(source: ETC/CCA elaboration based on EuroGeographics, 2015; INTERREG Balkan Mediterranean, 2017).

Like the ADRION and the Danube programmes, the INTERREG V B Balkan-Mediterranean is a new transnational cooperation programme, which joins parts of the previous discontinued (2007–2013) SEE programme. The programme covers three EU Member States (Bulgaria, Cyprus and Greece) and two countries financed by IPA instruments (Albania and the Former Yugoslav Republic of Macedonia (FYROM), thus overlapping with the Adriatic-Ionian, the Danube, the Central Europe and the Mediterranean transnational cooperation regions.

With regard to the territory of Albania, Greece and Cyprus the region is also covered by the Barcelona Convention (see section 3.9), while Bulgaria is a contracting partner of the Bucharest Convention.

2 Climate change, impacts and vulnerability in the transnational regions in Europe

KEY MESSAGES:

- All European transnational regions are vulnerable to various degrees to climate change: this is determined by the sensitivity of multiple sectors (e.g. water management, agriculture, forestry, biodiversity protection and infrastructure), and by enhanced exposure and increased sensitivity driven by non-climatic developments, such as changing land-use patterns and population change.
- Some European regions that are very vulnerable across multiple sectors have been identified as 'hot spots': the Northern Periphery and Arctic, Mediterranean (including large parts of the Adriatic-Ionian and Balkan-Mediterranean regions) and South West Europe regions, as well as the mountainous part of the Alpine Space. These regions have already been affected by observed impacts, and will likely be increasingly affected by the future impacts of climate change with negative effects across multiple sectors.
- The Arctic is warming at a rate more than twice the global average. Sea ice is undergoing a regime shift from multi-year ice to predominantly first-year ice. Loss of land-based ice is expected to accelerate, with implications for global sea level rise. Increased precipitation and reduction in Arctic snow cover and warming permafrost are on-going. The Arctic climate will continue to change over the coming decades, with major consequences for ecosystems, and human activities and human well-being.
- The severity and frequency of droughts appear to have increased and are expected to increase further in south-eastern Europe, with the greatest impacts in regions located in southern Europe. This would increase competition between different water users, such as agriculture, industry, tourism and households.
- Sea level rise relative to land along most European coasts is projected to be similar to the global average. Coastlines in the northern Baltic Sea and in the northern Atlantic Area represent an exception, as these areas are experiencing significant land rise due to post-glacial rebound.
- Forest ecosystems and services in the regions located in southern Europe (South West Europe, Mediterranean, Alpine Space, Adriatic-Ionian and Balkan-Mediterranean) will be affected by range shifts of tree species towards higher altitudes and latitudes, and by possible increases in forest fire risk and incidents of forest insect pests.
- Water resources and ecosystems in all mountain regions (e.g. Pyrenees, Alps and Carpathians) are expected to be negatively affected by climate change in the next decades. Hydropower production capacity is projected to decrease due to changing river flow regimes; winter tourism is likely to be negatively affected by reduced snow cover; and infrastructure and settlements will be negatively affected by increasing slope instabilities.
- In many transnational regions, climate change impacts affect shared resources and pose additional challenges for their joint management across borders. A prominent example is water resource management (with regard to both changes in seasonal flood risk and in water scarcity

situations during drought periods) in the Danube River basin, which is the most international river basin in the world.

- The Baltic Sea region, in particular its southern part, is expected to experience an increased risk of storm surges due to sea level rise, changing precipitation and run-off regimes, as well as biota shifts as a result of warmer coastal sea waters. This will increase existing problems, as the basin already has the largest 'oxygen-depleted zones' in the world.
- The Mediterranean region is projected to undergo further warming and drying with increase of heatwaves, dry spells and evaporation, and decrease in runoff, which will have severe impacts on several sectors, in particular water resource management, agriculture, forestry, biodiversity, tourism and energy. Due to critical overfishing, marine pollution and habitat destruction, the Mediterranean region may become a 'hot-spot of global change'.

Table 2.1: Overview of relevant observed and projected climate change and impacts along with relevant risks and opportunities for twelve European transnational regions

(Source: ETC/CCA elaboration based on collection, review and analysis of relevant literature and consistent with the Map ES.1 "Key observed and projected climate change and impacts for the main biogeographical regions in Europe" of the EEA Report 'Climate change, impacts and vulnerability in Europe 2016 An indicator-based report)

Transnational region	**Relevant observed and projected climate change and impacts**	**Relevant risks and opportunities**
Northern Periphery and Arctic	Large increase in air temperatures (above global average — 'Arctic amplification') Decline in extent of Arctic sea ice Decline in the Greenland ice sheet Decrease in permafrost areas Loss of unique ecosystems	The Northern Periphery and Arctic region is identified as a 'hotspot' of climate change Losses of livelihoods for indigenous peoples Risk from increasing resource demands and pollution due to tourism, global transport, fisheries and economic development New opportunities for transport, exploitation of natural resources, agriculture
Atlantic Area	Increases in air temperatures Increase in precipitation Increase in autumn and winter storms Increase in storm surges (except in the northern Atlantic coast) Increase in sea surface temperatures Sea level rise (in line with global averages) Increase in sea water acidification Biodiversity regime shifts	Increasing risk from heavy winter storms (coastal and river floods, heavy winds) Risks from ecosystem changes (acidification, ecosystem changes) on fisheries Opportunities from decrease of heating days
North West Europe	Increase in summer air temperature	Increasing risks from severe storms (winter and autumn)

Transnational region	**Relevant observed and projected climate change and impacts**	**Relevant risks and opportunities**
	Increase in winter precipitation Increase in winter storms Increase in coastal and river floods Increase in storm surges Biodiversity regime shifts	Increasing risk from coastal flooding due to relative sea level rise and storm surges Increasing risk from river flooding from extreme precipitation
North Sea	Increase in air temperature Increase in winter precipitation (in the northern part of the North Sea) and decrease in summer precipitation (in the southern part) Increase in heat extremes Decrease in cold extremes Increase in heavy precipitation events Increase in sea surface temperatures Sea level rise (in line with global averages) Increase in salt water intrusion into rivers Increase in harmful algal blooms Biodiversity regime shifts	Increasing risk of coastal flood damages Increasing risks of reduced availability freshwater due to salt water intrusion Increasing risk of algal blooms affecting human health, ecosystems and aquaculture Potential opportunities for agriculture (longer growing period and CO_2 fertilisation especially for the Northern part), but also increasing risks of droughts
Baltic Sea	Increase in air temperature (mainly in winters) Increase in winter precipitation Increase in sea surface temperatures Decrease in Baltic Sea ice extent	Increasing risk of algal blooms affecting human health, ecosystems and aquaculture Increasing risks for marine ecosystems and fisheries due to sea water acidification Increasing risks of vibriosis infections due to increase of sea

Transnational region	**Relevant observed and projected climate change and impacts**	**Relevant risks and opportunities**
	Sea level rise Increase in oxygen-depleted zones (already now the largest dead zone in the world) Increase in sea water acidification Increase in harmful algal blooms Biodiversity regime shifts	water temperature
Alpine Space	Increase in air temperatures (above global and European averages) Increase in precipitation (mainly in the northern Alpine rim) and decrease in precipitation (in the southern Alpine rim) Increase in frequency of small-scale extreme precipitation events Increase in frequency of summer droughts Decrease in glacier extent, snow pack and annual duration of snow pack Changes in river flow regimes Increase in permafrost thawing and increasing slope instability Biodiversity regime shifts	*The mountainous part of the Alpine Space is identified as a 'hotspot' of climate change* Increasing risk from debris flows, rock falls, landslides, avalanches and torrential processes affecting human lives, settlements and infrastructure due to permafrost thawing and small-scale extreme precipitation events Decreases in hydropower potential Decrease in winter tourism (decreasing snow reliability, duration of season, and economic viability of destinations at low to medium elevation levels) High risk of biodiversity loss and species extinction Increasing risks of losses of ecosystem services from forest calamities (pests, storms, water stress) New opportunities for summer cool-seeking tourism
Central Europe	Increase in air temperatures Decrease in summer precipitation and increase in winter precipitation	Increase of economic losses from extreme weather events Increasing risk of forest fires Decrease in economic value of forests due to ecosystem

Transnational region	**Relevant observed and projected climate change and impacts**	**Relevant risks and opportunities**
	Increase in frequency and/or intensity of heat extremes and heat waves Increase in frequency and/or intensity of droughts Increase in frequency and/or intensity of severe storms Increase in frequency and/or intensity of river floods Decrease in snow and ice coverage	change Increase in energy demand for cooling Increasing variability of crop yields
Danube	Increase in air temperatures Decrease in precipitation Increase in heat extremes and heat waves Increase in extreme precipitation events in winter (for the middle Danube basin) Increase in risk of storm-related heavy precipitation events (for the upper Danube basin) Increase in risk of river floods Decrease in overall water availability Increase in frequency of droughts (especially in the southern parts) Biodiversity regime shifts	Increasing risk of flood damages for urban areas Increasing risk of losses in water dependent sectors (e.g. agriculture, forestry, river navigation and water-related energy production) Increasing economic risks from slope instability due to permafrost thaw Potential opportunities for river navigation from reduced ice cover Potential opportunities of increasing crop yield due to extension of growing season
Mediterranean	Increase in air temperature (larger than global averages) Decrease in precipitation Increase in duration and intensity of heat waves	*The Mediterranean region is identified as a 'hotspot' of climate change* Increasing risk of heat related morbidity and mortality Increase in energy demand for cooling

Transnational region	**Relevant observed and projected climate change and impacts**	**Relevant risks and opportunities**
	Increase in frequency and intensity of droughts Decrease in water availability and river run-offs Increase in sea surface temperatures Increase in sea water acidification Sea level rise Loss of biodiversity in the marine ecosystems	Risk of decrease in summer tourism Increasing risk of conditions favourable for forest fires Increasing risk of losses for different water users (agriculture, energy production) Increasing risk of vector borne diseases Risk of losses of arable soil due to salinisation (irrigation and salt water intrusion) Risks from acidification to fishing
South West Europe	Increase in air temperatures (above global average) Decrease in precipitation Increase in heat waves Increase in frequency and intensity of droughts Increase in risk of desertification (decrease in water availability and river flows) Increase in frequency of forest fires Biodiversity regime shifts	*The South West Europe region is identified as a 'hotspot' of climate change* Increasing risk of heat related morbidity and mortality Increasing risk of economic losses for various water users (agriculture, energy production) Risk of economic losses from more frequent forest fires
Adriatic-Ionian	Increase in air temperatures Decrease in summer precipitation in the northern Adriatic Increase in frequency and intensity of heat waves Increase in frequency and intensity of droughts Biodiversity regime shifts	Decrease in summer tourism Losses for tourism due to beach erosion Negative impacts from changes in biodiversity, and invasive species on fisheries and infrastructure

Transnational region	**Relevant observed and projected climate change and impacts**	**Relevant risks and opportunities**
Balkan-Mediterranean	Increase in air temperatures Decrease in precipitation Increase in frequency and intensity of heat waves Increase in frequency of river floods Increase in frequency and intensity of droughts Sea level rise in the Black Sea	Increasing risks from heat-related morbidity and mortality, especially in low lying and coastal areas, with consequences for tourism Increasing risk of losses in forest productivity Risk of losses due to beach erosion along Black Sea coasts Increasing risk of losses from river flooding

2.1 Northern Periphery and Arctic

"*The Arctic's climate is shifting to a new state*" (AMAP, 2017b). The Arctic hosts a set of unique ecosystems, and plays an important role in the global climate system (EEA, 2017b).

Temperatures in the Arctic have increased about twice as fast ('Arctic amplification') as in the mid-latitudes (Overland et al., 2014). In the absence of a strong reduction in the Atlantic Meridional Overturning Circulation, the Arctic region is projected to continue to warm more than other regions (Collins et al., 2013). Model projections, under either a medium or high Greenhouse Gas (GHG) concentration scenario, show that before mid-century autumn and winter temperatures in the Arctic will increase to 4–5°C above late 20th century values. This is twice the increase projected for the Northern hemisphere as a whole. Recent observations show a widespread decline in periods of extreme cold during both winter and summer, and increases in extreme warm periods in some areas (AMAP, 2017b).

The faster than average increase in temperatures is a strong driver of climate-related changes in the Arctic. The Arctic is vulnerable to these temperature increases because they affect key features, such as sea ice extent and seasonal variation in ice and snow, the ice sheet mass balance, glaciers and permafrost, and snow cover with knock-on effects on the hydrology of Arctic waters (AMAP, 2011). Even if the world successfully achieves the mitigation goal of stabilising global temperatures near 2°C, the Arctic will still be a considerably different place by mid-century. Continuing present trends and projections, spring will arrive earlier and autumn will last longer, leading to more snow and ice melt, and enhanced disruption of existing marine and terrestrial ecosystems (AMAP, 2017b).

Sea ice extent continues a long-term downward trend. It is undergoing a regime shift from multi-year ice to predominantly first-year ice. Summer sea ice is very likely to disappear within the next few decades. Melting of the Arctic sea ice is opening up new transport routes and offers trade-related gains, but at the same time poses severe risks to the fragile nature and ecosystems in the region, and potentially increases the risk of for new geopolitical challenges. This will in turn strengthen the need for international cooperation in the Arctic (AMAP, 2017a). Sea ice is becoming more mobile as its extent and thickness decrease, increasing ice-related hazards; e.g. sea ice thickness in the central Arctic Ocean declined by 65% over the period 1975–2012 (AMAP, 2017b).

There are strong positive ice-temperature feedbacks in the Arctic, and thus the rapid warming and reduction in sea ice are likely to continue (Screen and Simmonds, 2010). Overall, the Arctic is becoming warmer and wetter (Boisvert and Stroeve, 2015).

Many of the smallest glaciers across the Arctic would disappear entirely by mid-century (AMAP, 2017b).

On-going reductions in Arctic snow cover and warming permafrost are both manifestations of change in the Arctic terrestrial coupled soil-vegetation-climate system, with impacts on energy, freshwater and carbon cycling (AMAP, 2017b). Societal impacts on infrastructure from permafrost warming will increase substantially between the current decade to mid-century (AMAP 2017a).

Arctic snow cover has continued to decrease, and its annual duration has decreased by 2–4 days per decade. The warming of near-surface permafrost in various areas of the Arctic is continuing, reaching more than 0.5°C since 2007–2009 in the high Arctic and other very cold areas. Snow cover and permafrost are projected to further decline: the duration of most of the Arctic snow cover could decrease by an additional 10–20% from current levels by mid-century under a high emissions scenario,

and the area of near-surface permafrost could decrease by around 35% under the same scenario (AMAP, 2017b). Future climate change may be accelerated by the thawing of Arctic permafrost (Schuur et al., 2015).

The Arctic is linked to the global climate system through north-south heat and water exchanges through atmosphere and ocean circulation, and through the global carbon cycle. Changes in the Arctic may be affecting weather in mid-latitudes, even influencing the Southeast Asian monsoon (AMAP, 2017b). The melting of land-based ice has accelerated in recent decades and will contribute significantly to sea level rise, which will have accelerated as well. The Arctic is projected to contribute 19–25 cm to global sea level rise by the year 2100. With increasing temperatures during the century, even with successful limitation of mean global warming near to 2°C, projected mass loss from glaciers and ice caps will not stabilise before the end of the 21st century due to the slow response times of Greenland ice sheets.

Climate models project an intensification of the Arctic water cycle: an increasing precipitation trend towards more rain than snow, and increasing precipitation in cold seasons of about 30–50% over the Arctic Ocean towards the end of this century (AMAP, 2017b).

The Arctic terrestrial and marine ecosystems and biodiversity are changing (e.g. modifications of the ranges of Arctic species, alterations of habitat uses and migration patterns, and decreasing plant cover and productivity) and are projected to face significant stresses and disruptions (e.g. changes in populations of ice-dependent species, losses of ice-associated algae and accelerated ecological shifts) (AMAP, 2017b).

The Arctic soils are estimated to hold about 50% of the world's soil carbon. So far the amount released to the atmosphere due to thawing permafrost over the past 60 years has been relatively small, but this amount is projected to increase substantially in the future, and contribute significantly to future greenhouse gas shifts (AMAP, 2017b).

Along with climate change as a key driver of change, other drivers that are often interrelated and interlinked need to be taken into consideration for the Arctic, such as global resource demands, tourism, global transport, fisheries, economic development and pollution (AMAP, 2017a, 2017b). In conclusion, the climate models project that in this century the Arctic could not return to previous conditions even with a large reduction of greenhouse gas emissions, and by the end of this century there is a risk that warming exceeds the thresholds for the stability of sea ice, the Greenland ice sheet, and possibly boreal forests (AMAP, 2017b).

2.2 Atlantic Area

The climate models project that increasing air temperature due to climate change will continue, along with high humidity as well increasing occurrences of heavy storms and other extreme weather events in the Atlantic Area. Most studies agree that the risk of severe winter storms, and possibly of severe autumn storms, will increase in the future for the North Atlantic and northern, north-western and central Europe (EEA, 2017b).

North Atlantic, as all other European seas, has warmed considerably since 1870, and the warming has accelerated since the late 1970s: the multi-decadal rate of sea surface temperature (SST) rise during the satellite era (since 1979) has been 0.21°C per decade (EEA, 2017b).

The rise in sea level relative to land along the coasts of the Atlantic area is projected to be similar to the global average, and will cause similar impacts on coastal zones with the exception of the northern Atlantic coast, which is experiencing considerable land rise as a consequence of post-glacial rebound (EEA, 2017b) resulting in lower ranges of relative sea level rise in this area. The projected increases in extreme high coastal water levels are primarily the result of increases in local relative mean sea level, but increases in storm activity can also play a substantial role, in particular along the northern European coastline (Vousdoukas et al., 2017).

Further to increased sea surface temperature and sea level rise, changes observed in the Atlantic Ocean are an increase in acidification, and increased ocean heat content (EEA, 2017b; OSPAR, 2017). Impacts from ocean acidification will affect marine ecosystems, with some organism groups increasing photosynthesis and growth, and others, especially highly calcified corals, molluscs and echinoderms, which sustain the growth of species important for fisheries, becoming more vulnerable (ICES, 2014).

Increases in sea temperature have triggered a major northwards expansion of warmer water plankton in the North-east Atlantic, and a northwards retreat of colder water plankton, which seems to have accelerated since 2000 (EEA, 2017b). Changes in the distribution of fish stocks alongside anthropogenic stressors, in particular overfishing, are projected to cause widespread changes to marine ecosystems, and with potential impacts on the coastal communities which are dependent on these fisheries (EEA, 2017b). Several species (e.g. migratory species moving northwards earlier and returning later than previously) have already shown changes in their behaviour, which may be a result of ongoing climate change (EEA, 2002).

In the Macaronesia region, encompassing the Azores, Madeira and Canary archipelagos in the Atlantic Ocean, annual temperature increase range between 0.30°C to 0.38 °C per decade in the 1981–2010 period, exceeding the global average by up to 0.10 °C per decade (Cropper and Hanna, 2014). The strongest increase was recorded in summer and particularly in the Canary Islands and Madeira. This trend is expected to continue in the future. Santos and Miranda (2004) estimate a temperature increase for the period 2070–2100 of between 1°C and 2°C in the Azores and 2°C and 3°C in Madeira. In the Canary Islands, the average temperature is expected to increase by 1°C by in 2040 (Sauter et al., 2013).

As for precipitation, observed trends do not signal any significant change between 1981–2010 (Cropper and Hanna, 2014). However, a change in annual precipitation patterns as well as extreme precipitation events has been detected across the whole of Macaronesia (EC, 2014d). There is high confidence that precipitation in the Canaries for the period 1970–2010 occurred in shorter, more intense episodes over fewer days (Tarife et al., 2012). Changes in annual precipitation patterns, with wetter summers and drier remaining seasons projected for the Azores (IPCC, 2007) and changes in seasonal precipitation are expected to have a major impact on water management in these islands, mainly on availability of freshwater resources. Precipitation is expected to substantially decrease in Madeira as well in the Canary Islands, where average precipitation is expected to decrease by between 20 and 35% by 2100 (Sauter et al., 2013).

Climate change is expected to adversely affect regional biodiversity. Patiño et al. (2016) found that the suitable area for Macaronesian endemic bryophyte flora will decrease by 62–87% per species and with a significant elevational increase by 2070. As a result, even the most common species are predicted to fit either the vulnerable or endangered categories of the International Union for the Conservation of Nature (IUCN). Complete extinctions are foreseen for six of the studied endemic species.

2.3 North West Europe

By the end of the 21st century, 90% of summers in southern, central and north-western Europe will be warmer than any summer in the period 1920–2014 under the Representative Concentration Pathway (RCP) 8.5 scenario (Lehner et al., 2016). Annual precipitation since 1960 shows an increasing trend of up to 70 mm per decade in north-eastern and north-western Europe (EEA, 2017b). An annual index for the maximum precipitation over five consecutive days (Rx5d) shows significant increases of up to 5 mm per decade over northern and north-western Europe in winter and up to 4 mm in summer between 1960 and 2015 (Donat et al., 2013; EEA, 2017b). Most climate models show further increases in precipitation, especially in the long-term and in more pronounced climate scenarios such as RCP8.5 (EEA, 2017b).

By the end of the 21st century, the largest increase in Q100 river floods (one-in-a-century river floods) is projected for the British Isles, north-west and south-east France, northern Italy and some regions in south-east Spain, the Balkans and the Carpathians (EEA, 2017b).

The risk of severe winter storms, and possibly of severe autumn storms, is projected to increase in the North Atlantic, as well as for northern, north-western and central Europe. Recent studies on changes in winter storm tracks generally project an extension eastwards of the North Atlantic storm track towards central Europe and the British Isles (EEA, 2017b).

Coastal flooding has had impacts on low-lying coastal areas in north-western Europe in the past. The risk of coastal flooding is expected to increase due to projected SLR and potentially stronger storm surges, with North Sea countries being particularly vulnerable. Stronger extreme precipitation events, in particular in winter, are projected to increase the frequency and intensity of winter and spring river flooding, urban floods and associated impacts (EEA, 2017b).

In addition, climate change will have a low to medium negative impact in most of the North West Europe region but with differences between areas: i.e. regions in the Netherlands, France, UK, Ireland and Luxembourg will be affected by low to medium negative impacts, while most regions in Germany and Belgium will not be affected (ESPON, 2013).

2.4 North Sea

The entire North Sea region is experiencing a change in climate and all available projections suggest the region will exhibit a wide range of climate change impacts over the coming decades (Quante and Colijn, 2016).

Temperature has increased in the North Sea region, particularly in spring and in the northerly area, e.g. linear trends in the annual mean land temperature anomalies are about 0.17°C per decade (for the period 1950– 2010) and about 0.39°C per decade (for the period 1980–2010). Generally, more warm and fewer cold extremes have been observed (Quante and Colijn, 2016).

Average warming for the North Sea region by the end of the 21st century (2071–2100, with respect to 1971–2000) is projected to be between 1.7 and 3.2°C for RCP4.5 and RCP8.5 scenarios, with stronger warming in winter than in summer in most countries of the region. Extreme events, hot days and heatwaves are expected to become more frequent in the future (May et al., 2016).

Precipitation has increased in the northern North Sea region, while summers have become warmer and drier and winters have become wetter. Heavy precipitation events have become more extreme (Quante and Colijn, 2016).

Climate models project an increase in mean precipitation during the cold season and a reduction during the warm season for the period 2071–2100 relative to 1971–2000, as well as a pronounced increase in the intensity of heavy daily precipitation events, particularly in winter, and a considerable increase in the intensity of extreme hourly precipitation in summer (Quante and Colijn, 2016).

Sea water temperature has been rising in the North Sea (with largest increase since the end of the 19th century exceeding 1°C in the south-east), despite a strong influence of natural variability, and this has mainly been accounted for by increases in air temperature (Huthnance et al., 2016). Annual mean sea-surface temperatures in the North Sea are projected to increase by 1 to 3°C by the end of the century for the A1B scenario (Quante and Colijn, 2016).

The North Sea region is particularly threatened by rising sea levels since this region mainly consists of coastal areas: absolute mean sea level has risen by about 1.6 mm/year over the past 100–120 years, comparable with the global rise. For example, the upper estimate of sea level rise for the Thames Estuary was quantified as 85 cm for the period 1990–2100 (Schrum et al., 2016). Saltwater intrusion caused by intensified drainage and/or SLR may occur, affecting the quality and the quantity of fresh water reserves, ecosystems and food production (Verhofstede et al., 2011; Quante and Colijn, 2016).

Observed wave heights in the North Sea region show a seasonal cycle: higher waves on average in the winter, and lower waves in the summer months. A clear climate trend is not yet visible in the historical series of measurements of wave heights and wind speeds. Wave heights vary from location to location in the North Sea region (Quante and Colijn, 2016). For the eastern parts of the North Sea, some climate models project an increase in mean and severe wave heights towards the end of the 21st century (2071–2100), and for the western parts of the North Sea (Grabemann et al., 2015; Grabemann and Weisse, 2008).

Coastal flooding has had an impact on low-lying coastal areas in north-western Europe in the past. These risks are expected to increase as a result of SLR and potentially stronger storm surges, with North Sea countries being particularly vulnerable (EEA, 2017b). Significant increases are projected in the eastern North Sea (by 6 to 8% for the 99th percentile of the storm surge residual, 2071–2100 compared to 1961–1990, based on a range of future scenarios (Debernard and Røed, 2008)). Increased coastal floods caused by storm surges have been estimated to lead to increases in insurable losses (Gaslikova et al., 2011).

The frequency and impact of natural disasters such as storm surges and floods will increase in the future whilst increased levels of rainfall and higher water levels in rivers are also expected. This directly threatens areas of central significance to the North Sea regions such as precious natural areas and densely populated urban areas along the North Sea coast.

Windstorms and coastal flooding could threaten energy and offshore activities (e.g. offshore installations such as rigs, offshore wind energy, pipelines, land coastal installations, and transportation) in the North Sea region. The future renewable energy potential could be affected by climate change: hydropower potential is expected to increase, uncertainty exist on the impacts on other renewable energy sources such as wind, solar, terrestrial biomass, or emerging technologies such as wave, tidal or marine biomass.

Comprehensive and systematic risk assessments focused on this sector are therefore needed in this region to account for the different national energy supply mixes and the vulnerabilities to climate change impacts in the North Sea countries (Halsnaes et al., 2016).

Climate change is expected to cause severe impacts on North Sea ecosystems and economic development. Projected climate change impacts on agricultural production do not appear to be all negative across the North Sea region: a doubling of atmospheric CO_2 concentration, along with adequate water and nutrient supply, could lead to yield increases of 20–40 % for most crops grown in this region. On the other hand, an increase of extreme weather events may severely disrupt crop production. Overall, the agriculture sector in the North Sea region, if able to adapt to the changing climate, has a potential to increase both productivity and profitability, particularly over the long-term, by ensuring sustainable growth without compromising environmental quality and natural resources (Olesen, 2016).

As a result of the projected warming, harmful algal blooms in the sea (in the adjacent Baltic Sea as well; see section 2.5) are projected to increase, posing a risk to human health, ecosystems and aquaculture (Glibert et al., 2014). In particular, warming of the North Sea has affected the distribution and abundance of plankton (the foundation of the marine food chain)[38] and shifted their seasonal cycles (Beaugrand et al., 2002; Edwards and Richardson, 2004). Changes in the plankton ecosystem linked to warmer surface temperatures have already harmed other species that rely on plankton for food, such as cod.

The decline of North Sea cod during the 1980–2000 period resulted from the combined effects of overfishing and of an ecosystem regime shift due to climate change (Beaugrand and Kirby, 2010). In addition, this stock has not recovered from its previous collapse during the 2000s (Mieszkowska et al., 2009). The steep decline in boreal species was compensated for by the arrival of southern (Lusitanian) species (ter Hofstede et al., 2010; Engelhard et al., 2011; Lenoir et al., 2011). Further climate change is expected to intensify these effects on North Sea plankton, cod, and marine ecosystems[39], with implications for the fishing industry and the communities that depend on it. Hence, an effective management and governance of the North Sea fishery will need to adapt accordingly (Pinnegar et al., 2016).

2.5 Baltic Sea

Despite large multi-decadal variations, there has been a clear increase in surface air temperature in the Baltic Sea region since the beginning of the observational record in the region in 1871. Linear trends in annual mean temperature anomalies from 1871 to 2011 were 0.11°C per decade north of 60 °N and 0.08°C per decade south of 60 °N (BACC II Author Team, 2015). Climate models project increasing air temperatures in the Baltic Sea area (over land and sea) with time, with a rate of increase greater than the global level. The particularly strong winter increase is due to a positive feedback mechanism: declining snow and sea-ice cover lead to even higher temperatures, e.g. greater amounts of heat to be stored in the soil and water. In summer, warm extremes are projected to become more pronounced during the summer seasons (BACC II Author Team, 2015).

[38] http://cpmr-northsea.org

[39] http://www.waddensea-secretariat.org

No long-term precipitation trend was observed for the whole region, but there is some indication that there was a tendency towards an increase in precipitation in winter and spring during the latter half of the 20th century (BACC II Author Team, 2015). The precipitation is projected to increase in winter over the entire Baltic Sea run-off region, while in summer it is projected to increase mostly for the northern half of the basin only. On the other hand, precipitation is projected to change very little in the southern Baltic Sea region (BACC II Author Team, 2015).

No statistically significant long-term change has been detected in total river run-off to the Baltic Sea during the past 500 years. However, increased annual, winter and spring stream flow values, as well as earlier snowmelt floods, were observed in the northern regions, whereas a decrease in annual discharge from southern catchments of the Baltic Sea of about 10% has been observed over the past century.

All European seas have warmed considerably since 1870, and the warming has been particularly rapid since the late 1970s. The multi-decadal rate of SST increase during the satellite era (since 1979) has been 0.40°C per decade in the Baltic Sea. The annual mean SST of the Baltic Sea increased by up to 1°C per decade in the period 1990–2008, with the greatest increase in the northern Bothnian Bay. Overall, a clear trend in salinity cannot be detected. Oxygen-depleted 'dead zones' in the Baltic Sea have increased more than 10-fold, from 5,000 to 60,000 km^2, since 1900, with most of the increase happening after 1950. The Baltic Sea now has the largest dead zone in the world. The primary cause of oxygen depletion is nutrient input from agricultural fertilisers, causing eutrophication, but the effects are exacerbated by climate change, in particular increases in sea temperature and in water-column stratification (EEA, 2017b).

Future climate change is projected to warm the Baltic Sea, to decrease its salinity, to decrease sea ice extent by 50–80% during the 21st century, and to further expand oxygen depleted 'dead zones' (EEA, 2017b). In particular, an increase in summer SST is projected for the Baltic Sea during the 21st century under medium to high emissions scenarios at about 2°C in the southern parts and about 4°C in the northern area (HELCOM, 2013). An increase in harmful algal blooms, with increased risks to human health, ecosystems and aquaculture, has been projected as a result of the projected warming (Glibert et al., 2014). In addition, the waters of the Baltic Sea are projected to become more acidic in the future (HELCOM, 2013). Such changes will affect many marine organisms and could alter marine ecosystems and fisheries. These rapid chemical changes are an added pressure on marine calcifiers and the ecosystems of Europe's seas.

Long-term changes in the phytoplankton communities have been observed in the northern Baltic Sea and the Gulf of Finland in the past 30 years: a decline in the spring bloom and an increase in the phytoplankton biomass during summer. These changes appear to reflect both climate-induced changes and the eutrophication process (EEA, 2017b).

The maximum sea ice extent in the Baltic Sea shows a decreasing trend since about 1800. The decrease appears to have accelerated since the 1980s, but the interannual variability is large (Haapala et al., 2015). However, the frequency of mild ice winters (defined as having a maximum ice cover of less than 130,000 km^2) has increased from seven in 30 years in the period 1950–1979 to 15 in the period 1986–2015. The frequency of severe ice winters, defined as having a maximum ice cover of at least 270,000 km^2, has decreased from six to four during the same periods (EEA, 2017b). Projections of Baltic Sea ice extent suggest that the maximum ice cover and ice thickness will continue to shrink significantly over the 21st century with an estimate of the decrease in maximum ice extent of 10,900 km^2/decade for

the high emissions scenario RCP8.5. Ice-free conditions in the Baltic Sea are projected under RCP8.5 by the end of the century (Luomaranta et al., 2014).

The glacial isostatic adjustment or post-glacial rebound has a strong influence in the Baltic Sea area, affecting relative sea level, which is decreasing in the northern Baltic Sea region (where the continental crust is rising) and is rising in the southern Baltic Sea region (where the continental crust is sinking) (BACC II Author Team, 2015). Climate models project the relative sea level along the Northern Baltic Sea coastline will increase at a slower rate with respect to the global projected rise, or even decrease (Church et al., 2013; Slangen et al., 2014; Johansson et al., 2014; HELCOM, 2013).

There is some evidence that the intensity of storm surges may have increased in recent decades in parts of the Baltic Sea, and this has been attributed to long-term shifts in the tracks of some types of cyclone rather than to long-term change in the intensity of storms. The Baltic Sea region, in particular its southern part, is expected to experience an increased risk of storm surges due to sea level rise, changing precipitation and run-off regimes, and biota shifts as a result of warmer coastal sea waters (BACC II Author Team, 2015).

The occurrence of vibriosis infections has increased substantially in Baltic Sea states since 1980. This increase has been linked to observed unprecedented increases in sea surface temperature. The large number of vibriosis infections in 2014 has been attributed to the 2014 heatwave in the Baltic region (EEA, 2017b).

Finally, the Baltic Sea biodiversity will be affected by water temperature and salinity variations due to climate change, and could undergo to a cascading effect on food webs and interaction between aquatic and terrestrial ecosystems, e.g. invasion by non-indigenous aquatic bird species (causing major changes in coastal bird communities) and invasion of mammalian predators (causing major changes in coastal and archipelago ecosystems) (BACC II Author Team, 2015).

2.6 Alpine Space

In the Alpine Space, observations show a larger increase in surface air temperature than the global average (observed annual mean temperature increase of +2°C, i.e. nearly twice as much as the average global warming rate) (Auer et al., 2014; Gobiet et al., 2014). Based on processing of multi-model climate simulations with a focus on the Alpine region (Heinrich and Gobiet, 2012; Heinrich et al., 2013; Gobiet et al., 2014), seasonal mean temperature is projected to increase by +1.7°C in summer and by +1.6°C in winter by the first half of the 21st century (2021–2050, compared to 1961–1990) under the A1B emissions scenario. Further increase of annual mean temperature by +3.5°C by 2100 is considered almost inevitable for the A1B scenario; Schöner et al. (2010) calculated a best estimate of +4°C until the end of the century (A1B). In all simulations, the Alpine main ridge shows warming at above average values (Gobiet et al., 2014). Based on the A2 emissions scenario, earlier simulations by the PRUDENCE project gave results showing temperature increases of +5.0°C in summer and +3.5°C in winter by 2100 (Christensen and Christensen, 2007).

An observed increase in annual precipitation has been detected in the north-west, and a decrease in the south-east of the Alps (Auer et al., 2005, 2007, 2014). By the middle of the 21st century, annual mean precipitation is projected to change only slightly by +3.7 % in winter and -3.1 % in summer under the A1B scenario (Gobiet et al., 2014). The spatial distribution of changes in seasonal precipitation appears to be influenced by the Alpine main ridge: during spring, summer and autumn, precipitation tends to increase

in the north of the Alps, whereas decreases are expected in the south and western parts of the Alps (Gobiet et al., 2014). By the end of the century, climate scenarios project a more distinct, wetter trend in winter (A1B: +10%; A2: +20%) and a general drying trend in summer (A1B: –20%; A2: –26%), which is most pronounced in the south of the Alpine region (Christensen and Christensen, 2007; Gobiet et al., 2014).

In addition, an increase in the intensity and frequency of extreme weather events, including in particular small-scale heavy precipitation events is expected across the entire Alpine region (ESPON, 2013; Gløersen et al., 2012; EEA, 2017b).

The Alpine glaciers are decreasing in ice mass: since 1900, Alpine glaciers have decreased in ice mass by about 50% (Zemp et al., 2008, 2015; Huss, 2012), and a recent study (Radić et al., 2014) has estimated a loss of between 84% and more than 90% of their current volume by 2100 under RCP4.5 and RCP8.5 scenarios respectively. This ablation of glaciers can increase the risk of glacier lake outbursts in high-Alpine terrain.

A reduction of snowfall, likely due to long-term global warming, has been observed in the Alps (Serquet et al., 2011) and is projected to continue in the future (Beniston, 2012). From 1950 to 2017, average and maximum snow depth and duration of snow cover have significantly decreased in most regions of the Austrian Alps; this trend is expected to continue at least at lower and intermediate altitudes over the long-term (Koch and Schöner, 2015; Schöner et al., 2016, 2018). Both decreasing snow pack and decreasing annual duration of snow cover affects hydrological cycles and winter tourism (EEA, 2017b).

Water availability is projected to decrease in summer, and the risk of drought periods is projected to rise in different parts of the Alps. Furthermore, the hydrological system is projected to become more sensitive to extreme weather events. The impacts of changing river flow regimes on hydropower production capacities are a key issue for energy production in the Alpine region, in particular in the longer term (Ballarin-Denti et al., 2014; EEA, 2017b).

Thawing permafrost causes destabilisation of mountain slopes and growing risks of rock fall to human lives, settlements and infrastructure (Mair, et al., 2011). Risk of gravitational mass movements (debris flows, landslides, rock fall, avalanches, and torrential processes) is increasing and will affect human settlements and infrastructure, and rising flood risk will affect low-lying basins and downstream valley areas especially in winter and spring. Combined with ongoing expansion of built-up areas, this increases the exposure of the built environment and human lives to natural hazard risks, making the Alpine Space show high "*susceptibility to climate–related natural hazards*" (Gobiet et al., 2014; EEA, 2017b). In addition, higher erosion rates due to more frequent and more severe heavy precipitation events are expected (EEA, 2017b).

Multiple climate stresses (less water supply in summer, bark beetle infestations, storms, shift in tree species composition, etc.) are destabilising forest ecosystems, threatening their protective and regulative ecological functions, and causing considerable damage and repair costs to forestry and the forest-wood production chain (Umweltbundesamt, 2007, 2013).

The up- and northward shift of climatic vegetation zones as well as invasive alien species will cause increased biodiversity loss and species extinction rates in the Alps, with animal and plant communities in the highest elevation zones being most vulnerable (EEA, 2017b).

2.7 Central Europe

The Central Europe region partially overlaps with the Carpathian mountains, which is almost entirely included in the Danube region. Information on climate change, impacts and vulnerability related to the Carpathian area is thus included in section 2.8 about the Danube region and specifically Box 2.1.

Due to the effects of climate change, the Central Europe region has to deal with increasing average air temperatures and an increasing number of extreme weather events such as droughts, heatwaves, floods, storms and landslides (EEA, 2017b). In particular, the climate of the 20th century in Central and also Eastern Europe was characterised by an overall temperature increase, although more pronounced in the Alps and their surroundings than elsewhere in this region. Other climate elements, such as precipitation, have developed diversely with regional increases and decreases of smaller amounts. For the southern part of Central Europe temperature increased significantly by about 1.2 C during the 20th Century. This increase was similar in all of the sub-regions of Central Europe (Auer et al., 2007).

For all of Central and also Eastern Europe a clear temperature rise is projected for the future. A general pattern is that the projected increase of temperature is highest during summer and lower during winter (Anders et al., 2014). In particular, in Central and also Eastern Europe the mean annual temperature is projected to increase between 1°C and 3°C by the middle of the current century and up to 5°C by the end of this century (Giorgi et al., 2004; Räisänen et al., 2004; Rowell, 2005; Déqué et al., 2007), if no policy measures are taken.

A shift of precipitation from summer to winter is projected for this region by the end of this century. The summer precipitation all over Central Europe (except along the Baltic Sea coastlines) will decrease, while in most cases Central Europe will most likely become wetter in the winter season. Despite these precipitation increases, the amount of snow and area covered by snow are expected to decline due to warming. In contrast, the projections for the summer months show a decrease in precipitation especially in the southern parts of Central Europe (Anders et al., 2014). The projected reduced summer precipitation can increase drought risk, health risks and energy demand in summer. On the other hand, the projected increase in winter precipitation can exacerbate the intensity and frequency of river floods in winter and spring in various areas of Central Europe. Furthermore, increased risks of forest fires and higher crop-yield variability are projected in this region (EEA, 2017b).

Two of the most costly climate extremes to have an impact on Central Europe in recent decades are the 2002 flood (EUR 20 billion) and the 1999 winter storm 'Lothar' (EUR 14 billion) (EEA, 2017b). Several studies (Zappa et al., 2013; Feser et al., 2015; Pardowitz, 2015; Baatsen et al., 2015) show that the risk of severe winter storms, and possibly of severe autumn storms is projected to increase for Central Europe (as in the North Atlantic and in northern and North West Europe).

The retreat of glaciers in the Central Europe region will continue, and one study (Radić et al., 2014) has estimated the projected relative loss of volume to be large (83 ± 10 % for RCP4.5 and 95 ± 4 % for RCP8.5).

Meteorological and hydrological droughts have increased in severity and frequency in Central Europe (EEA, 2017b). Furthermore, effects such as drought-induced decline of tree species (Siwkcki and Ufnalski, 1998; Mátyás et al., 2010) or changes in population dynamics of climate sensitive pests (Hlásny and Turčáni, 2009; Lakatos and Molnár, 2009) have already been reported.

Finally, climate change is expected to also have a profound effect on Central European forests (Tatarinov and Cienciala, 2009; Hlásny et al., 2011a, 2011b).

2.8 Danube

According to the climate scenarios analysed, temperature is likely to increase in the future with a gradient from northwest to southeast, and in all seasons. In the period from 2021 to 2050, annual mean temperature is expected to rise between 0.5°C in the upper basin parts and 4°C in the lower basin parts of the Danube River Basin (DRB)[40], whereas from 2071 to 2100 an increase between 2.5°C and 5°C is projected. At the end of the century, the increase is expected to be particularly large in summer in the south-eastern region of DRB, with a possible bandwidth between 3°C to 6°C (BMUB et al., 2012; ICPDR, 2013). The summer months are projected to be 15% drier with respect to the present, and could be 20% drier especially in the southern Danube river basin area (Bisselink et al., 2018).

Large regional and seasonal changes in future precipitation are projected for the 21st century. A general decrease in summer precipitation above 20% (reaching 30% for the southern Danube countries around the end of this century) and an increase in winter precipitation in most areas of between +5% and 20%, up to +35% in some parts, are to be expected (BMUB et al., 2012; ICPDR, 2013; Bisselink et al., 2018).

Climate models project a future increase in extreme weather events for the whole DRB: both a future increase in the intensity and frequency of dry spells, hot days and heatwaves, as well as local and regional increases in heavy rainfall (but with uncertainty in spatial and temporal allocation). An increased risk of storm-related heavy precipitation with high wind speeds is projected for the upper Danube Basin. On the other hand, the risk of extreme precipitation days is expected to increase in winter and to decrease in summer for the middle Danube Basin (BMUB et al., 2012; ICPDR, 2013).

Water availability is projected to decrease for the next decades in the southern and eastern parts of DRB, whereas it is projected to remain the same or slightly decrease in the northern and western parts. Furthermore, water storage in the form of snow and ice is expected to decrease. Mean annual potential evaporation is projected to increase due to warmer temperatures across almost the whole DRB, especially in summer, which could lead to intensified water stress. On the other hand, evaporation will decrease in the south-eastern parts of DRB with low water availability, especially during dry periods, because less water would be available to evaporate or transpire through plants (ICPDR, 2013). In future, DRB could be exposed to higher flood risks, but also the risk of water scarcity during the drier summer months, especially in the southern regions of the Danube basin. Increased peak Danube river flows around 10–20% larger than under the current climate are projected under a 2°C changed climate and around 10–30% larger under more extreme climate change (around 3.5–4°C increase at the end of this century). These larger peak flows will increase the risk of flood damage for urban areas along the main Danube (Vienna, Budapest and Belgrade) or its main tributaries (Zagreb) (Bisselink et al., 2018).

[40] The term Danube River Basin (DRB) refers to the geographic area of interest to the work of the International Commission for the Protection of the Danube River (ICPDR). It includes the territories of 19 countries whose river sub-basins and catchment areas have a share in the entire Danube River Basin. Those 14 countries that have a share of more than 2,000 square kilometers in the basin are contracting parties of ICPDR. The geographic coverage of the Danube River Basin, as the term is used in the ICPDR context, is not fully identical to the programme area of the INTERREG Danube Transnational Programme (DTP), but both are overlapping to a large extent.

Groundwater recharge in DRB is projected to increase during winter months and to decrease during the summer months (Bisselink et al., 2018). The permafrost in mountainous areas of the Danube region will further retreat, leading to a higher frequency of rock falls and more sedimentation in rivers (ICPDR, 2013).

Droughts, low flow situations and water scarcity periods are likely to become more intense, longer and more frequent in DRB, especially during the summer months in the southern and eastern part of the Danube basin. Under 2°C of climate change, water exploitation is projected to increase in some seasons for Bulgaria, Hungary, Serbia, Bosnia-Herzegovina and Romania, but also decrease in other seasons and areas. Under a more extreme climate change scenario (around 3.5–4°C increase at the end of this century) a heavy increase in water scarcity is projected for Bulgaria, Serbia, Romania, Hungary, Slovakia and Moldova, especially in the summer months (Bisselink et al., 2018). Together with an expected increase in water temperature, good water quality might be at risk. Moreover, a general increase in water demand from households, industry and agriculture together with a pronounced water scarcity during the summer months is likely to lead to further high water stress (BMUB et al., 2012; ICPDR, 2013; Bisselink et al., 2018).

Box 2.1 Climate change and vulnerability in the Carpathian mountains

The Carpathian mountains cover an area which is almost all included in the Danube transnational region, with the exception of Poland.

Observed temperatures in the Carpathians have clearly risen in the period 1961–2010, increasing by 1.0°–2.4°C in summer. An increase in the frequency and intensity of heatwaves has been also observed (Werners et al., 2014). In addition, an increase in the number of hot days has been observed in all areas, whereas here has been a decrease in the number of days of extreme cold temperatures in the western part, and an increase in the north-eastern part of this area (Spinoni et al., 2015a).

A warming trend is shown in all scenarios for the whole of the Carpathians during the first half of the 21st century, with a summer increase of 1.2°C in the north and up to 2°C in the South. The highest temperature increase is projected in the southern mountain ranges. The temperature increase becomes stronger in the second half of the century: an increase of about 2–3°C, is projected under the RCP4.5 scenario, reaching up to 5°C under the RCP8.5 scenario (Alberton et al., 2017).

Precipitation decreases in western and south-eastern parts of this area, and increases in the north and northeast have been observed along with increases in summer and winter precipitation, and decreases in spring (Alberton et al., 2017). Projections of precipitation show a decrease in summer, particularly in the south and in the mountains by up to –20 mm per month (2071–2100, compared to 1971–2000), and show an increase of up to 20 mm in winter, particularly in the north. (Werners et al., 2014).

Periods of intense precipitation are expected to be more frequent and could lead to increased runoff and decreased infiltration. This precipitation trend combined with reduced water availability, and higher summer temperatures will increase the risk of summer droughts all over the Carpathians, i.e. the frequency and severity of drought events could increase (Werners et al., 2014). The increase of more frequent intense precipitation events along with the increase of more frequent droughts will lead to an increased risk of floods, erosion, landslides and wildfires (Alberton et al., 2017).

Bisselink et al., (2018) estimated the projected future impacts of climate change, land use change and changes in water consumption on water resources in DRB and have found that climate change is the dominant factor. Land use change (urban expansion) plays a smaller role and future water demand increase as a result of Gross Domestic Product (GDP) growth will be subordinate to the influence of the climate. Water-dependent sectors such as agriculture (irrigation), forestry, river navigation and water related energy production will likely suffer under these projected future conditions, since they will face longer periods with a substantial lack of water to carry out their activities, thus leading to a loss of production (Bisselink et al., 2018). Changes in ecosystems and biodiversity with shifts in the aquatic and terrestrial flora and fauna are to be expected. Possible positive effects of climate change in this region may be improved river navigation due a reduction of ice days on rivers, or longer growing seasons in agricultural production (BMUB et al., 2012; ICPDR, 2013).

2.9 Mediterranean

The Mediterranean region has been identified as a 'hotspot' of climate change, e.g. being very vulnerable to the current and future climate change impacts with a high number of economic sectors being severely affected (Giorgi, 2006; Giorgi and Lionello, 2008; Lionello et al., 2006; Lionello and Scarascia, 2018; Navarra and Tubiana, 2013a, 2013b). Furthermore, the Mediterranean Sea could

become a 'hot-spot of global change' through the combination of climate change with critical overfishing, marine pollution and habitat destruction (Micheli et al., 2013).

An increase in surface air temperature and a decrease in mean precipitation are confirmed by observations, and have led to a progressive and substantial drying of the Mediterranean land surface since 1900 (e.g. a change of the Palmer Drought Severity Index by -0.2 units per decade) (Alpert et al., 2013; Ulbrich et al., 2013; Navarra and Tubiana, 2013a).

The annual mean surface air temperature trend in the Mediterranean region over the 1960–2005 period has been estimated to be 0.19–0.25°C per decade, and over 0.3°C per decade during the summer months (Mariotti et al., 2015). The warming rate for the Mediterranean region is projected to be about 20% larger than the global rate, with pronounced increases in summer and in the continental areas north of the Mediterranean basin undergoing warming in general 50% greater than at the global scale, and locally as much as twice as great (Lionello and Scarascia, 2018). In particular, climate model simulations project a surface warming of about 1.5°C in winter and about 2°C in summer, with a decrease in mean annual precipitation (about 5%) in this region for the period 2021–2050 compared with the period 1961–1990 under A1B scenario, with the largest changes projected for the summer months (Gualdi et al., 2013b, 2013a). In addition, both the daily and annual temperature range are likely to increase in magnitude in summer more than in winter (Lionello and Scarascia, 2018). It is important to note that Mediterranean regional and global temperatures warmed at a similar rate until the 1980s, but uncertainty due to decadal variability has been shown in identifying long-term links between precipitation in the Mediterranean region and global temperature (Lionello and Scarascia, 2018).

Observations confirm an annual mean precipitation trend of around $-0.6\ 10^{-2}$ mm/day/decade for the last century over the Mediterranean region (Mariotti et al., 2015). Climate models project a general decrease of precipitation in the Mediterranean region at a rate around −20 mm/K or −4%/K (mm/K and %/K are units describing the tendency of regional precipitation to increase or decrease with global warming), in particular affecting the central and southern Mediterranean areas in all seasons, with the largest reduction for winter precipitation (−7 mm/K or −7%/K for the southern Mediterranean region). On the other hand, in areas along the northern border of the Mediterranean region, the projected reduction of precipitation will be largest in summer (−7 mm/K or −9%/K for the whole northern Mediterranean region) and minimal in winter (Lionello and Scarascia, 2018).

Heatwave duration and frequency has been observed to increase more than six-fold since the 1960s (Kuglitsch et al., 2010). Climate models project further warming and drying in the Mediterranean region, with an increase of heatwaves, dry spells and evaporation, and a decrease in runoff (Gualdi et al., 2013a).

The runoff of most of the largest rivers decreased (at least 20%) in the Mediterranean Sea during the 1960–2000 period, due to the reduction in annual precipitation and the construction of dams (Ludwig et al., 2009), and an increase in the atmospheric evaporative demand (Vicente-Serrano et al., 2016).

Model projections show that the frequency and duration of extreme meteorological droughts will significantly increase in the future (Stagge et al., 2015). These projections showed the largest increases in frequency for extreme droughts in parts of the Iberian Peninsula, southern Italy and the eastern Mediterranean, particularly at the end of this century with respect to the 1971–2000 baseline period. The changes are larger for the RCP8.5 scenario and slightly less extreme for the RCP4.5 scenario.

Water use and abstraction will exacerbate minimum low-flows in many parts of the Mediterranean region, leading to an increased probability of water deficits when maximum water demand overlaps with minimum or low availability (EEA, 2017b). A decline in water availability is projected in the Mediterranean region, and reduced run-off and groundwater resources, because of increasing demand from other sectors and economic costs, will affect future irrigation (Olesen et al., 2011). Furthermore, the climate simulations under different specific scenarios developed in the context of the LIFE project MEDACC (Demonstration and validation of innovative methodology for regional climate change adaptation in the Mediterranean area)[41] project a strong influence of forest areas on river flows and highlight the importance of land use planning as a key tool for mitigating the observed and projected effects shown by the climate change scenarios (Pascual et al., 2016).

Modelled soil moisture content has shown a significant decrease in the Mediterranean region since the 1950s, due to past warming and precipitation changes. Significant decreases in summer soil moisture content in the Mediterranean region are projected for the coming decades (Kurnik et al., 2015). Projections for the end of the 21st century show significant decreases in summer soil moisture content in the Mediterranean region (López-Moreno et al., 2009; Orlowsky and Seneviratne, 2013).

Marine observations have found that the Mediterranean SST has increased over the last half-century (Sevault et al., 2014), e.g. with rates of increase of 0.2–0.3°C per decade during 1979–2006 period (Mariotti, 2010), and that the Mediterranean surface salinity did not change significantly in the eastern basin, but showed a small increase in the western Mediterranean (Navarra and Tubiana, 2013a). Climate models project a further increase of the sea temperature, which along with a projected runoff decrease could increase sea salinity. As a result, these compensating effects on the density of sea water could keep the stratification of the Mediterranean Sea constant in the future.

A decrease in significant wave height is estimated in the Mediterranean Sea of –5 cm under the RCP8.5 scenario, –3 cm under the RCP4.5 scenario, and 0 cm under the RCP2.6 scenario (Perez et al., 2015).

Sea level data have shown a rise of about 150 mm in the last two centuries in the Mediterranean (Navarra and Tubiana, 2013b). The steric component sea level is expected to increase by about 15 cm in 2050 under the A1B scenario, although this result does not completely represent the total sea level (Gualdi et al., 2013b). In addition, Adloff et al. (2015) estimated a projected basin average thermal expansion range from +34 to +49 cm by the end of this century under the A2 scenario. Additional inputs to Mediterranean sea level increase can be attributed to the melting of mountain glaciers, adding a further rise of 10–60 cm (Spada et al., 2013) and by changes in the northeast Atlantic circulation adding an additional 10–30 cm (Bouttes et al., 2014). Finally, taking into consideration all potential contributions and uncertainties, the mean Mediterranean Sea level could increase by between 40 cm and 110 cm by the end of this century with respect to the present climate (Sabrié et al., 2016). On the other hand, salinity in the Mediterranean Sea may increase in the future which could offset rises in sea level due to thermal expansion from warming. Sea level rise will further increase salinisation of coastal aquifers, further endangering the modest water resources in this region.

[41] MEDACC project (LIFE12 ENV/ES/000536; http://medacc-life.eu/) is a 5-year multi-actor project (started in the summer of 2013) and aims at testing innovative solutions in order to adapt agro-forest and urban systems to climate change in the Mediterranean basin.

The pH of Mediterranean waters has decreased by 0.05 to 0.14 pH since the preindustrial period (Luchetta et al., 2010; Touratier and Goyet, 2011). This acidification indicates that the Mediterranean Sea waters are already acidified, especially those of the Western basin. Both the anthropogenic CO_2 concentrations and acidification levels are closely linked to the presence and history of the different water masses in the intermediate and deep layers of the Mediterranean basins. Despite the high acidification levels, both Mediterranean basins are still highly supersaturated in calcium carbonate minerals (Hassoun et al., 2015).

The observed invasion and survival of alien species has been correlated with the warming trend in Mediterranean SST. In the eastern Mediterranean Sea, the introduction of warm water and tropical alien species from the Red Sea has been enhanced by observed warming, leading to a 150% increase in the annual mean rate of species entry since 1998 (Raitsos et al., 2010).

In the Mediterranean region the danger of forest fires will increase with respect to the present. Recently, large forest fires have repeatedly broken out in Mediterranean countries. Data available for five EU Mediterranean countries (Portugal, Spain, Italy, Greece, and France) show wildfire variability in time and space, but the variability of fire damage is evident with some years where the weather conditions contributed to amplification of the impacts (de Rigo et al., 2017). The Mediterranean region is projected to become drier, and as a result will likely suffer an increase in weather-driven forest fires. In fact, the projected increase in the numbers of droughts and heatwaves across most of the Mediterranean region and southern Europe is likely to increase the length and severity of the fire season, the area at risk and the probability of large fires, possibly enhancing soil erosion and desertification (Moreno, 2014). This high risk of forest fires will cause reductions in biomass, biodiversity, and provision of ecosystem services in the Mediterranean region (de Rigo et al., 2017). Spain, Portugal and Turkey are the countries with the highest risk of forest fires, while Greece, central and southern Italy, Mediterranean France, and the coastal Balkan region show an increasing danger both in relative and absolute terms (de Rigo et al., 2017).

In addition, the highest soil loss rates are found in the Mediterranean area, mainly due to a combination of high rainfall erosivity and steep topography (Panagos et al., 2015a). The loss of arable lands due to salinisation caused by sea water intrusion from sea level rise and increased use of irrigation is expected to increase in future (UNEP/MAP/PAP, 2015).

The energy sector will be affected by decreasing water availability and increasing energy demand for heating, and particularly cooling in summer. The tourism potential in this region is projected to decline markedly during the summer months, but could improve in other seasons (EEA, 2017b). As a result the Mediterranean region will be one area of Europe affected by multiple stresses and systemic failures due to climate change (IPCC, 2014).

The most severe health risks are projected for low-altitude river basins in southern Europe and for the Mediterranean coasts, where many densely populated urban centres and the main tourist resources of the area are located (Fischer and Schär, 2010).

Navarra and Tubiana (2013a) estimated the economic costs of impacts in the Mediterranean region, by showing negative economic consequences for sectors such as tourism and energy. Furthermore, all Mediterranean countries could lose, on average, 1.2 % of GDP in 2050 with the largest economic costs related to sea level rise and tourism. In the Mediterranean, climate change also interacts with other non-

climatic drivers (Navarra and Tubiana, 2013a), such as urbanisation and other socio-economic modifications, land use changes (Santini and Valentini, 2011), or changes in tourism flows. All these factors combined are likely to cause a significant increase in climate-related risks and vulnerabilities in this region.

2.10 South West Europe

Climate change is expected to considerably affect the SUDOE region. This region has already experienced the strongest warming in the whole of Europe since 1960, particularly during summer (up to 0.36°C per decade in Catalonia in the 1950–2017 period (BAIC, 2018). By the end of the century, and compared to the baseline period 1971–2000, mean annual temperature is further expected to rise between 1.9–2.7°C for RCP4.5 and 3.9–5.4°C for RCP8.5 (Jacob et al., 2013). In most of Southern Europe, each decade since 1960 has experienced an increase in the number of unusually warm days by up to 10 days (EEA, 2017b). While periods of extreme high temperatures are projected to become more frequent and severe across the whole continent, Southern Europe will experience the greatest increase (Russo et al., 2014).

Mean annual precipitation has decreased by up to 90 mm per decade across the whole peninsula, and in particular in central Portugal. Projections for the end of century under the RCP8.5 scenario indicate a decrease in mean annual precipitation of up to 40 % with respect to the 1971–2000 period (EEA, 2017b).

An increase in mean sea level ranging between 1.5 mm/year in the Mediterranean Spanish coasts (with important regional and rate variations up to 3.1 mm/year in Costa Brava over the last 28 years (BAIC, 2018)) and 2 mm/year in the Cantabrian Sea of Spain have been registered in the last 60 years along the Spanish coastlines, and have recently shown an accelerated rate of increase (Losada et al., 2014).

Meteorological, hydrological and agricultural droughts, in particular, pose a major threat for this region. The Iberian peninsula has already experienced many severe droughts in the past decades, and it is likely to be affected by longer, more frequent, and intense events even under a moderate emission scenario and both in the near (2041–2070) and far future (2071–2100) (Spinoni et al., 2015b).

Changes in climatic conditions will affect a large number of sectors in the SUDOE region, most of which will be negative impacts (IMPACT2C project, 2015). These include reduced water availability, losses in crop yields and biodiversity, heat-related morbidity and mortality, increased risk of forest fires, droughts and desertification (EEA, 2017b).

Furthermore, the SUDOE region includes the Pyrenean mountain region, which is already affected by climate change impacts (see Box 2.2). Finally, the Iberian Peninsula has been considered a hotspot for negative climate impacts on ecosystems and their services (EEA, 2017b).

Box 2.2: Climate change impacts and vulnerability in the Pyrenean region

Observed and projected climate change impacts are affecting and will affect key socio-economic and biophysical sectors in the Pyrenees. Rising temperatures together with climate variability will result in a decrease in the spatial expansion, persistence and thickness of snow cover affecting winter tourism, a key economic sector for the region (OPCC and CTP, 2013). For a +4°C scenario it has been estimated that only 7% of the Pyrenean ski resorts would be operable due to insufficient snow cover during winter if no adaptation measures are taken (Pons et al., 2015).

Climate change is also affecting the phenology, distribution and composition of many highlands species and communities, leading to alterations in the different mountain ecosystems. Climate change in synergy with land use changes is altering the diversity and distribution of many plant communities and forest species in the Pyrenees (Matías, 2012). Over the last 50 years, on the southern slopes of the Pyrenees, the upper limit of many forests has shifted by 35 metres higher, at an average of half a metre per year (Ameztegui et al., 2016). The combined effect of the gradual abandonment of mountain agro-pastoral activities and climate change impacts is leading to the recolonisation and forestation of many abandoned pastures. It has been found that a shift in altitude of forest limits is affecting all alpine meadows communities, and rare or specialist species are been especially affected (Rixen and Wipf, 2017).

Current communities of endemic species such as the Pyrenean triton (*Calotriton Asper*), the Pyrenean ptarmigan *(Lagopus muta pyrenaica*) or the sarrio (*Rupicapra pyrenaica*) could be negatively affected in the coming decades due to the combined impacts of habitat loss and climate change (Kourkgy et al., 2016; García-González et al., 2016; Morán-Tejeda et al., 2017).

The loss of glacier mass has accelerated in recent decades. From 1984 to 2016, it is estimated that 20 of the 39 glaciers recorded in 1984 have disappeared, resulting in a loss of Pyrenean glacier surface equivalent to 516 ha (López-Moreno et al., 2016; Navarro-Serrano and López-Moreno, 2017).

Accumulated annual precipitation is projected to decrease by 10–20 %, with the greatest decline (about 40%) during the summer season (López-Moreno et al., 2011; Meaurio et al., 2017). These changes will have sizable effects downstream, as major river basins such as the Ebro, the Garonne and the Adour are supplied from the Pyrenees (EEA, 2017b). In return, more heavy rain events, as projected by the main climate models, will probably lead to an increased flood risk, soil erosion (Panagos et al., 2015b) and landslides, particularly during autumn (Turco et al., 2017; Llasat et al., 2017), which could affect settlements, tourism and energy infrastructure.

Hydroelectric power generation is also expected to be affected, especially in the Catalan Mediterranean Pyrenees and in the Nouvelle-Aquitaine Atlantic Pyrenees. During 2012, there was an estimated 40% decrease in hydropower capacity in large part of the Catalan dams compared to average production in the period 2003–2007 (OPCC and CTP, 2013).

With respect to climate extremes, more frequent and intense droughts would increase wildfire risks, the vulnerability to pests in agriculture and the risk of additional changes in composition and quality of high mountain pastures (Dumont et al., 2015; Das et al., 2017). More intense and frequent heatwaves would increase vulnerability to thermal stress and diseases in livestock and agriculture, and have serious impacts on sensitive high mountain ecosystems (Camarero and Catalan, 2012; Rico et al., 2017).

2.11 Adriatic-Ionian

The increase of annual mean temperature in the Adriatic-Ionian region has been less intense compared to other areas of the Mediterranean (between 0.05 and 0.3°C for the period between 1960 and 2015) and shows decreasing levels from north to south (EEA, 2017b). In terms of projections, in the whole Mediterranean area, including the Adriatic-Ionian region, mean surface temperature increases are expected to be more intense in the summer period under all RCP scenarios (EEA, 2017b). In particular, warming of up to 5°C towards the end of the this century is projected for the eastern Adriatic area (Branković et al., 2013). High-resolution climate projections under the RCP8.5 and RCP4.5 scenarios conducted over the whole SEE show a general warming in all seasons, but more pronounced in winter and summer with a warming of 1.5°C higher under RCP8.5 than under the RCP4.5 scenario for the 2042–2070 period with respect to 1972–2000 data. The most pronounced warming occurs in summer under RCP8.5 scenario with a temperature increase of 5.5°C in the western part of the simulated domain (Montesarchio et al., 2013).

Annual mean precipitation has decreased in the whole Mediterranean region, especially in the summer period, a trend which is expected to continue under all climate projections (EEA, 2017b). A study showed that in the northern Adriatic region, precipitation is projected to increase in winter and decrease in summer by 20% (+0.5 mm/day and 1 mm/day over the Alps, respectively) (Zampieri et al., 2012). These results are confirmed by Montesarchio et al. (2013), who found a decrease of summer precipitation over the whole Alpine area and the Northern Adriatic area under the RCP8.5 scenario.

Extreme heatwaves are projected to become more frequent, intense and longer lasting under all RCP scenarios in southern Europe and south-eastern Europe area, which includes the Adriatic-Ionian region (EEA, 2017b), e.g. occurring approximately every two years between 2050 and 2100 under the RCP8.5 scenario (Russo et al., 2014).

Trends in extreme rainfall show some, but not statistically significant, decreases in central and south-eastern Europe, and based on data and indices which are in some cases insufficient for identifying trends and changes (EEA, 2017b).

Regional projections for sea level for relatively small isolated and semi-closed ocean basins, such as the Mediterranean (including the Adriatic basin), are more difficult than for the open ocean. Salinity in the whole Mediterranean Sea may increase in the future and this could partially offset rises in sea level due to thermal expansion from warming (EEA, 2017b) (see section 2.9).

In addition, the pH of Adriatic-Ionian seas has decreased since the preindustrial period in line with the pH trend of Mediterranean waters (Luchetta et al., 2010; Touratier and Goyet, 2011).

In conclusion, the Adriatic-Ionian region will be further affected by impacts such as: (i) increase in tendency towards hot summers, which may contribute to a decrease in summer tourism; (ii) change in the marine environment, which, along with sea level rise, sea surface warming and changes in salinity and in acidity, may drive changes in biodiversity and species distribution and increase the presence of invasive species, and affect coastal zones and infrastructure (EEA, 2017b).

The Adriatic-Ionian region includes most of the Western Balkan area and Box 2.3 provides a brief description of the climate change, impacts and vulnerability of that area.

Box 2.3: Climate change impacts and vulnerability in the Western Balkans

The Western Balkans, included in the Adriatic-Ionian, the Balkan-Mediterranean and the Danube regions, is a mountainous region and a hotspot of climate change. Over the past decades, warming has accelerated, and throughout the 21st century, warming levels are projected to be higher than the world average (Alfthan et al., 2015). The observed changes in precipitation over the past few decades are less clear, but overall a decrease in precipitation has been observed in most of the region, with Albania, Croatia and FYROM displaying the clearest downward trend. The mountain region of Gorski Kotar in Croatia had the greatest decrease. Bosnia and Herzegovina, Montenegro and Serbia experienced mixed or unchanging precipitation patterns. Within the region, the Dinaric Alps generally receive the most precipitation (Lelieveld et al., 2012). The mountains in the Western Balkans are therefore central to the flow of fresh water (Schneider et al., 2013), as decreasing precipitation and increasing evapotranspiration combine to make the region, and soils in general, drier.

Droughts have become significantly more common in FYROM, Serbia and Kosovo under United Nations (UN) Security Council Resolution 1244/99. Almost all climate models agree that the countries within the region will experience a significant decrease in precipitation within the 21st century, accompanied by an increase in drought conditions and therefore water availability. Annual flow reduction in the regions' rivers of up to 15% are projected at 2°C warming above preindustrial levels, and by up to 45% in a 4°C world. Overall, climatic extremes are projected to become more common, including a significant increase in the number of extreme heat events. Heavier precipitation events are expected in the winter months, whilst summers are projected to become even drier.

The following mountain-specific climate hazards already have an impact in this region and are projected to have further impacts in the future: reduced snow cover (up to 50 days less by 2050 across the Dinaric Arc), increased occurrence of winter and spring flooding from intense precipitation and accelerated snowmelt; increases in the frequency and intensity of wildfires; heavy snow precipitation and cold extremes; the appearance of new disease vectors; and decreasing annual river discharge and low flow periods (Alfthan et al., 2015).

2.12 Balkan-Mediterranean

Climate models project increases in annual mean temperature and, in particular, in summer temperature, in the Balkan-Mediterranean region and generally in the whole eastern Mediterranean. As a result, Balkan countries will be particularly affected by warming in the summer season (Önol and Semazzi, 2009).

In addition, extreme heatwaves have become more frequent during the past decades especially in southern and south-eastern Europe (EEA, 2017b). For the future, these extreme events are projected to become more frequent, intense and to last longer under all RCP scenarios. Under the RCP8.5 scenario, extreme heat events are projected to occur approximately every two years between 2050 and 2100, especially in southern and south-eastern Europe (Russo et al., 2014). By 2100, summer temperatures under the RCP8.5 scenario will generally exceed the hottest temperatures measured in the period between 1920 and 2014 (Lehner et al., 2016). In the Eastern Mediterranean and the Middle East (EMME), including in particular the Balkan Peninsula and Turkey, hot summer conditions that rarely occurred in the 1961–1990 period may become common by the middle and the end of the 21st century.

Daytime maximum temperatures are expected to increase most rapidly in the Balkan Peninsula and Turkey under intermediate Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) scenario A1B (Lelieveld et al., 2012).

The most severe health risks are projected for low-altitude river basins in southern Europe and for the Mediterranean coasts, where many densely populated urban centres and the main tourist resources of the area are located (Fischer and Schär, 2010).

In general, annual precipitation is expected to decrease in southern Europe, while seasonal rainfall is expected to increase in winter and to decrease in spring and summer, with a substantial increase in the number of days without rainfall (Lelieveld et al., 2012). However, changes in precipitation patterns can be very different depending on the specific location: according to Önol and Semazzi (2009), a significant increase in winter precipitation may be expected by the end of the 21st century over the Carpathian Mountains (see Box 2.1) and along the east coast of the Black Sea, whereas the Mediterranean countries such as Greece and Turkey are expected to experience a decrease.

For the end of the 21st century, the greatest increase in one-in-a-century river floods is projected for, among others, the Balkans and the Carpathians (EEA, 2017b).

While sea level rise relative to the Mediterranean coasts of this region has already been discussed in the preceding sections (see 2.9 and 2.11), here attention is given to the Black Sea coasts. A study using satellite altimetry data for the Black Sea found a mean rate of SLR of 3.19 ±0.81 mm/year in the 1993–2014 period, confirming (in agreement with tide-gauge measurements) that the mean sea level of the Black Sea has risen rapidly (Avsar et al., 2015). Furthermore, an assessment of the erosion risk of Black Sea beaches has been conducted under different SLR scenarios showing that sea level rise may have highly significant impacts on Black Sea beaches: in a 0.5 m SLR scenario about 56% of all beaches are projected to retreat by up to 50% of their maximum width, if the high mean of the ensemble projections is considered; in a 0.82 m SLR scenario about 41% are projected to retreat by their entire maximum width; and finally in a 1 m SLR scenario about 51% of all Black Sea beaches are projected to retreat (drowned or shifted landward) by their entire maximum width, if the high mean of the model ensemble projections is used. These results confirm that the risk of beach erosion must be considered a major environmental issue along the Black Sea coasts (Allenbach et al., 2015).

Regional impacts of climate change in the eastern Mediterranean and the Middle East include heat stress, associated with poor air quality in urban environments and increasing scarcity of fresh water (Lelieveld et al., 2012, 2014), while *per capita* water resources will not change significantly in south-eastern Europe (Chenoweth et al., 2011).

The projected increases in the risk of droughts and disturbances in southern and eastern Europe will negatively affect the growth of forests and cause losses in forest productivity (Sirotenko and Abashina, 2008; Lavalle et al., 2009; Lindner et al., 2010; Keenan et al., 2011; Silva et al., 2012; Hlásny et al., 2011a).

3 Cooperation programmes and initiatives for adaptation

KEY MESSAGES:

- Only three out of the 12 INTERREG V B programmes within continental Europe (South West Europe, North Sea and Atlantic Area) have assigned a specific funding priority for CCA and DRR. In the remaining programmes, CCA is defined as a horizontal or cross-cutting theme or as a mainstreaming goal alongside other topics, e.g. climate mitigation.
- Three transnational regions (Baltic Sea, Alpine Space and Danube) have developed common adaptation strategies or action plans, while some other regions are taking initial steps in this direction without having, so far, fully developed tangible outcomes.
- The Baltic Sea Region Climate Change Adaptation Strategy is a direct outcome of a transnational cooperation programme, while in the Alpine and the Danube regions, other international institutions (the Alpine Convention and the International Commission for the Protection of the Danube River, respectively) were the driving forces behind the formulation of adaptation strategies and plans.
- Based on the Danube Adaptation Strategy, adaptation measures have been integrated into the Danube River Basin Management Plan and the Danube Flood Risk Management Plan.
- Transnational activities have been more successful in creating collaboration on common adaptation initiatives and projects in areas with existing transboundary and regional collaboration networks and structures.
- Further to transnational cooperation programmes, EU macro-regional strategies and conventions can play an important role in triggering action on climate change adaptation.

In addition to adaptation efforts in Member States, the EU Strategy on Adaptation to Climate Change calls for transboundary collaboration especially when dealing with shared resources such as river basins and coastal areas. In this sense, transnational regions which share common geographic characteristics and challenges are at an advantage in preparing for joint adaptation projects.

As reported in Chapter 1, the primary instruments through which the EU finances cooperation in transnational regions are the INTERREG cooperation programmes, and in particular INTERREG B. Box 3.1 provides an attempt of confrontation between funding priorities and expenditure of 2014–2020 INTERREG transnational programmes. Only three programmes have earmarked funding for CCA and DDR in specific objectives, while in the remaining programmes only rough estimates can be made about the resources potentially available for Climate Change adaptation. In those areas where specific funding priorities exist, resources attributed to CCA range between slightly approximately 5% of the overall budget for the North Sea Region and between 11 and 12% in SUDOE and the Atlantic region. In remaining programmes with CCA as a horizontal priority or a mainstreaming issue, very rough estimates show a share between 12.7 (Danube Region) and 22.6% (Mediterranean Region) of overall funding potentially available for CCA activities.

Box 3.1: Financing of climate change adaptation in INTERREG B programmes 2014–2020

The background study for the evaluation of the EU Strategy on Adaptation to Climate Change suggests, citing a study by COWI (2017), that under ERDF and Cohesion funding EUR 6bn has been allocated to adaptation, corresponding to 11.2% of the total expenditure for cohesion policies (EC, 2018c).

A more specific analysis of the resources devoted to CCA and DRR within the INTERREG B programmes proves to be challenging, as the number of projects approved is difficult to assess because of the lack of comprehensive databases and will necessarily be incomplete given the on-going selection processes. The allocation of funds in operative programmes can be used as a proxy, although in the current programme period (2014–2020) only three out of 12 INTERREG B programmes in continental Europe have dedicated a specific priority axis to the specific thematic objective (TO) 5 'Promoting climate change adaptation, risk prevention and management' as defined by the EU Regulation on ERDF funding (EU, 2013b).

The remaining programmes attributed the role of horizontal priority to CCA and DRR or aimed to mainstream adaptation into other themes, as for instance into the thematic objective 'Supporting the shift towards a low-carbon economy in all sectors'. In these cases, an assessment of funding dedicated to CCA or DRR is almost impossible. However, evidence from a screening of projects approved shows that none or only a very few projects which have been financed so far under respective thematic objectives where CCA should have been mainstreamed, have actually succeeded in addressing synergies with adaptation (see e.g. section 4.1.3 on North West Europe). In an attempt to quantify the overall volume of adaptation-related investments in INTERREG B programmes, further to the budget attributed to specific thematic objectives, funding for priorities regarding "environmental protection" and "low carbon economy" was taken into account, assuming these to give a 'moderate' contribution to adaptation- and resilience-related objectives. Nevertheless, not all funding under these priorities will be dedicated to CCA and DRR, so, following a strategy used by the European Court of Auditors, a weight of 40% was attributed to budgets under priorities, (EU, 2013c; European Court of Auditors, 2016).

This represents a potentially consistent overestimation of resources employed (European Court of Auditors, 2016). The potential overestimated character of these figures is suggested by the differences in percentages between programmes with dedicated priorities on CCA and DRR such as North Sea (4.48% of the total budget), Atlantic Area 10.89% and SUDOE (12.05%) and the estimated allocations in other programmes, ranging at much higher levels in terms of share of the overall investments of between 18.17% (ADRION) and 22.59% (Balkan-Mediterranean).

This would in any case exceed the percentages estimated by COWI, who estimated a share of 4.3% as European Structural and Investment Funds (ESIF) support for adaptation (COWI, 2017). Regarding this latter consideration, it will be highlighted that in the analysis performed for this paper the exact distinction between environmental focused and climate change priorities could be defined only for few programmes; for the great majority a rough estimation of the potential contribution on mainstreaming of CCA and DRR into other thematic objectives has been made (see Figure 3.1).

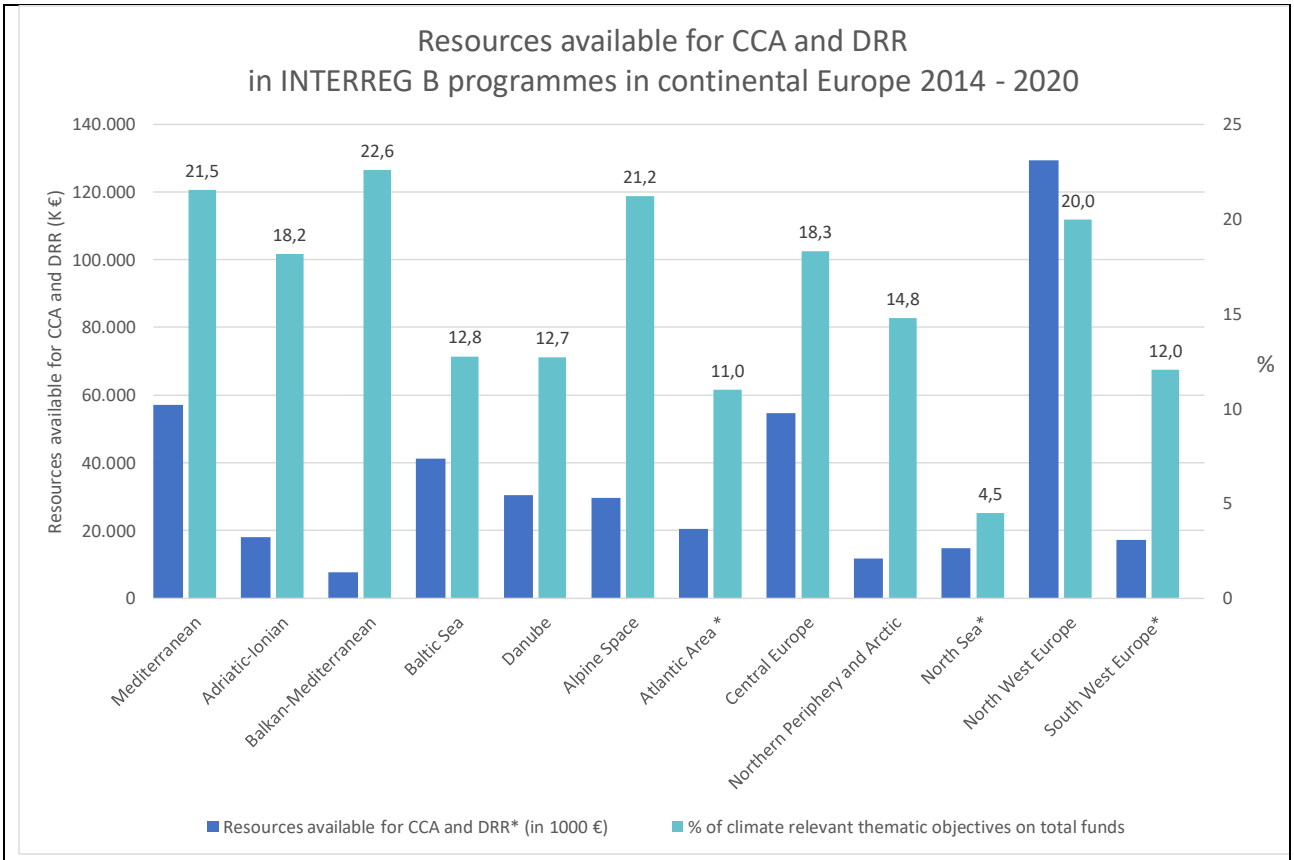


Figure 3.1: Potential investments in climate change adaptation and resilience in INTERREG B programmes

(source: our elaboration based on data from EC, 2018a); regions marked with have a dedicated priority topic on climate adaptation, while the remaining regions have mainstreamed CCA and DRR into other topics.*

In this chapter we report on climate change adaptation and disaster risk reduction interventions planned and implemented in the 12 transnational regions programmes (overseas entities are addressed in Annex 1) and examine their relationships with further international policy initiatives in the same geographic space. We focus on:

- INTERREG cooperation programmes;
- EU macro-regional strategies;
- Conventions;
- Other cooperation initiatives;
- Transnational strategies and plans on climate change adaptation promoted within the 12 transnational regions.

Apart from the INTERREG cooperation programmes, which are illustrated for all the 12 regions, the other elements are described only for those regions where they actually occur and are relevant.

Reference is made to the present (2014–2020) and previous (2007–2013) programming periods of INTERREG B, with the aim of highlighting the progressive integration of adaptation considerations within

the cooperation programme. While INTERREG programmes supporting EU-macro-regional strategies focus explicitly on regional and local levels of governance, most other initiatives are based on inter-governmental interactions at national level. This difference has some implications for the direct availability of financial resources at regional level and eventually the higher potential for establishing effective governance structures and mechanisms ensuring implementation of planned actions in these regions. Examples for other territorial aggregation structures (the Conference of Peripheral Maritime Regions, and the EU strategic approach to marine security) are presented in overview boxes (respectively Box 3.2 and Box 3.3).

Box 3.2 Conference of Peripheral Maritime Regions (CPMR)

The Conference of Peripheral Maritime Regions (CPMR) represents European coastal regions situated on coasts and islands. Members are regions from European Member States and neighbouring countries. Its goal is to lobby European institutions and national governments for policies promoting a more balanced development of the European territory and to operate as a think-thank for the participating regions. While focusing mainly on social, economic and territorial cohesion, including maritime policies and blue growth, it also addresses climate change policies. The activities are organised in policy areas, and in some cases supported by working groups and task forces, in particular with regard to cohesive policies, with a task force supporting EU macro-regional strategies in general and one specific task force for the Adriatic-Ionian area.

The work is furthermore organised in regional commissions, each of them covering one of the principal regional seas (Atlantic Arc, North Sea, Baltic Sea, Balkan and Black Sea, and the Mediterranean). An Island commission furthermore represents major and minor islands in all European seas and the outermost regions. The areas covered largely overlap with the transnational coastal regions as defined by INTERREG, although not all regions participating in the INTERREG programmes are also members of CPMR.

Climate change adaptation is considered a priority and CPMR has established a climate task force 'Energy and Climate' led by the Brittany and Noord-Holland regions, which is interacting with European Commission (EC) on specific adaptation challenges and solutions with regard to the partner regions[42], and has produced, *inter alia*, a policy paper in the context of the revision of the EU Adaptation Strategy (CPMR, 2017). Only some of the regional commissions have set up activities with regard to climate change adaptation. An example for regional commissions acting on CCA is represented by the North Sea commission (see section 3.4)

3.1 Northern Periphery and Arctic

INTERREG cooperation programmes

The INTERREG V B Northern Periphery and Arctic Programme 2014–2020[43] (INTERREG NPA, 2016) considers adaptation explicitly in its thematic objectives as well as in one of its three horizontal thematic aspects (i.e. environmental sustainability), underlining the need to implement adaptation measures. The NPA programme is expected to contribute to the generation of adaptation knowledge, which is required

[42] http://cpmr.org/policy-work/energy-climate/climate-task-force/

[43] http://www.interreg-npa.eu

for the development of other relevant and much-needed skills as well as awareness-raising (INTERREG NPA, 2016).

During the previous programming period, one of the Northern Periphery Programme's (NPP) 2007–2013[44] two priorities focused on sustainable development of natural and community resources, under which climate change adaptation was specifically mentioned.

Other cooperation initiatives

The Arctic Council[45] is the leading intergovernmental forum in the Arctic region. It has circumpolar coverage, which makes it larger than the Northern Periphery and Arctic transnational region defined within INTERREG B. Its members are national governments (Canada, Denmark including Greenland and the Faroe Islands, Finland, Iceland, Norway, the Russian Federation, Sweden, United States) and representatives of Arctic indigenous communities and other Arctic inhabitants. Climate change has been addressed, in particular, by AMAP, as well as by other working groups of the Arctic Council.

The Nordic Council of Ministers is the intergovernmental cooperation forum of European Nordic states. In a report commissioned by the Nordic Council, adaptation to climate change is defined as one of 12 strategic recommendations for inter-governmental co-operation and it is suggested to "*develop a Nordic Action Plan for climate resilience of ecosystems and diversity in nature*" (Sundtoft, 2018). During the previous cooperation programme (2015–2017) the council addressed climate change as one of its focal areas (Nordic Council of Ministers, 2014) and initiated the 'Adaptation Actions for a Changing Arctic' (AACA) project conducted by AMAP[46]. One of three pilot regions of the project is the Barents region, for which local adaptation challenges were discussed in a series of participatory scenario workshops (Nilsson et al., 2017). Results of the AACA project were summarised in an assessment report specifically focused on adaptation actions in the Barents area (AMAP, 2017a). The report identifies key environmental and socio-economic changes, assesses the adaptive capacity in the region and discusses adaptation options and adaptation actions. The report also provides key strategies and tools intended to inform decision-makers about possibilities for helping their communities adapt to future change.

Adaptation strategies and plans

The Barents Euro-Arctic Council (BEAC) is a forum for intergovernmental cooperation specifically for the Barents region, and has Denmark, Finland, Iceland, Norway, Russia, Sweden and the European Commission as its members. The BEAC has adopted the 'Action Plan on Climate Change for the Barents Co-operation' in 2013 (BEAC, 2013). Originally endorsed at a meeting of the Finnish, Norwegian, Russian and Swedish Foreign Ministers, it was adopted by the Environment Minsters of the BEAC countries. The plan contains concrete activities to be realised by the working groups under the Barents Euro-Arctic Council, including a proposal to develop regional climate strategies in the whole Barents region. The action plan was slightly revised and published in a second edition in 2017 (BEAC, 2017).

[44] http://www.northernperiphery.eu

[45] http://www.arctic-council.org

[46] https://www.amap.no/adaptation-actions-for-a-changing-arctic-part-c

3.2 Atlantic Area

INTERREG cooperation programmes

For the period 2014–2020 the INTERREG V B Atlantic Area Programme (INTERREG Atlantic Area, 2018) focuses on four priorities which are articulated in seven objectives. Among these, adaptation is addressed in priority 3 'Strengthening the territory's resilience to risks of natural, climate and human origin' and the related objective 3.1 'Strengthening risks management systems'.

In the previous programming period, climate change adaptation was addressed in the context of priority 2, dedicated to the protection and enhancement of the marine and coastal environment sustainability principally addressing risks derived from sea level rise and coastal erosion, and of priority 4 in relation to sustainable urban and regional development.

Conventions

The OSPAR Convention covers a wider area than the EU transnational Atlantic Area region, including, in addition to three Atlantic regions (Celtic Seas, Bay of Biscay and Iberian Coast, and Wider Atlantic), two other regions: Arctic Waters and the Greater North Sea. Under this convention, climate change (and ocean acidification) are addressed as a cross-cutting issue in terms of knowledge generation, monitoring of impacts and design of management options aimed at increasing ecosystem resilience (OSPAR, 2010).

Other cooperation initiatives

The Maritime Strategy and Action plan for the Atlantic Ocean Area (EC, 2011a, 2013a)[47] covers the same area as the Atlantic region, as well as some overseas territories (St. Martin, Guadeloupe and Martinique). It addresses CCA and DRR as a potential obstacle to sustainable growth, which are here tackled with strategies for knowledge generation. In particular, ocean observation, mapping and forecasting are considered critical for the sustainable growth of economic activities in the Atlantic area and the need for (public) information and climate services for the actors in the area (EC, 2013a).

The Atlantic Arc Commission under CPMR covers most of the regions participating in the Atlantic area. Following the statement of CPMR, "… *that regional authorities can play an active role in improving energy efficiency and promoting a low carbon economy across their territories*", work in the Atlantic Arc Commission is mainly focused on the implementation of the Atlantic maritime strategy. Its Atlantic Strategy working group had been initially set up for promoting the creation of a macro-regional strategy following the example of EUSBSR, but since the EC decided to set up a sea basin strategy for the Atlantic Area, it now aims to follow up the implementation of the Atlantic maritime strategy.

[47] http://www.atlanticstrategy.eu/en

Box 3.3: European Sea Basin strategies

For regions including large portions of sea such as the Atlantic Area, the Baltic Sea, the Mediterranean and the Adriatic-Ionian, European regional sea basin strategies also fulfil functions of transnational strategies, aimed at regional collaboration for maritime sustainable growth (Blue Growth) and cohesion such as macro-regional strategies. The degree of integration between EU macro-regional strategies and sea basin strategies differs among regions. The EUSAIR is an evolution of the Adriatic Maritime Strategy (EC, 2012b) into a macro-regional strategy, while in the EU Strategy for the Baltic Sea Region (EUBSR) a Blue Growth Agenda was integrated in 2014 (EC, 2014a). In the case of the Atlantic region, no macro-regional strategy has been developed and the Atlantic Maritime Strategy takes, to a certain extent, the place of a macro-regional strategy as a framework for transnational economic and social cooperation between regions[48].

In addition, all European maritime areas are covered by the EU Maritime Security Strategy (EU, 2014b), adopted in 2014. The related Action Plan (EU, 2014a) includes managing the impact of climate change in maritime areas and coastal regions as a security issue of concern. The scope of this action plan covers all European sea areas and the external EU maritime borders. It indicates a group of actions for assessing vulnerability and improving the climate resilience of maritime transport and connected infrastructure (EU, 2014a, p. 16).

3.3 North West Europe

INTERREG cooperation programmes

The INTERREG V B NWE programme for the period 2014–2020 identified addressing climate change vulnerability as one of the major challenges in the programme area, due to the high urban density and the exposure of urban areas to the risk of coastal and fluvial flooding. Nevertheless, this challenge has not been translated into a thematic priority for the programme, and has only been included among the investment priorities related to the transition to a low carbon society, stating that "*mitigation/adaption actions are required*" (INTERREG NWE, 2015). Among the projects approved so far (June 2018) none is expected to deliver mitigation strategies that also have an adaptation function (see section 4.1.3).

The Strategic Initiative Cluster 'Adaptation to the Spatial Impacts of Climate Change' (SIC Adapt)[49] was created for promoting and achieving effective climate adaptation throughout the NWE region by clustering eight of the adaptation-related projects funded under the 2007–2013 programming period. The clustering aimed to strengthen the impact of single projects, especially at higher policy levels; creating synergies and promoting the adoption of adaptation measures. The cluster produced, *inter alia*, recommendations for better integrating climate adaptation into INTERREG programmes in the following 2014–2020 period. The recommendations suggest a double strategy within the programmes with respect to climate change: (1) to dedicate a specific priority to the challenge and (2) to integrate it as a strong integral cross-cutting issue into all relevant priorities of a programme, by defining selection criteria related to the project's potential impact on climate change and its adaptation-related contents.

[48] https://cpmr-atlantic.org/policy-work/atlantic-strategy-task-forces/atlantic-strategy-cooperation/

[49] https://www.keep.eu/keep/project-ext/21125/SIC+adapt%21?ss=5ae18f7b9516547b74a788ff5ec7d577&espon=

The project ended in 2013, and, as stated above, in the new programming period, no specific priority was dedicated to the challenge (see section 4.1.3).

Other cooperation initiatives

The area overlaps with the transnational cooperation areas of the Atlantic region for the western parts and the North Sea region for its north-eastern part. There is no overlap with other transnational collaboration programmes for the inland regions participating in the North West Europe area, and no EU macro-regional strategies or international conventions are dedicated to this territory.

No common adaptation plan is in place for the entire area. The Benelux states (The Netherlands, Belgium and Luxemburg) which are part of the area, are currently exploring the opportunities of a common vulnerability and risk assessment focusing on cascading effects and impacts of extreme events across the borders of the Benelux countries (Benelux, 2017).

3.4 North Sea

INTERREG cooperation programmes

The NSR programme (INTERREG NSR, 2015a) acknowledges that the most serious threat facing NSR ecosystems is climate change and highlights that climate change mitigation and adaptation initiatives are needed to protect NSR countries. The North Sea Programme for the previous period 2007–2013 (INTERREG NSR, 2008), recognises vulnerability to the effects of climate change as an issue and adaptation has been the focus of several projects funded by the programme.

Conventions

The OSPAR Convention also covers the Greater North Sea (Region II according to the OSPAR definition) which is part of the overall North-East Atlantic as defined by this convention (see section 3.2 on the Atlantic Area and Box 1.4) for more details.

Other cooperation initiatives

Along the North Sea coast, a cooperation initiative has been developed between the Netherlands, Germany and Denmark for the protection of the Wadden Sea (an area of extended tidal flats along the North Sea coasts of the three countries involved). Cooperation is based on a declaration of intent, the 'Joint Declaration on the Protection of the Wadden Sea', which was first signed in 1982 and updated in 2010. The declaration defines the objectives and areas of the cooperation and the institutional and financial arrangements[50]. The Trilateral Wadden Sea Cooperation[51] has proposed several activities focusing on CCA. These include the 'Workshop on Best practices of Climate Change Adaptation in the Wadden Sea Region' organised in 2017[52] and the 'Wadden Sea Climate Change Adaptation Information Platform'[53], which provides access to documents relevant policy or science reports for the region.

[50] http://www.waddensea-secretariat.org/trilateral-cooperation/about-the-cooperation

[51] http://www.waddensea-secretariat.org/

[52] http://www.waddensea-secretariat.org/about-us/events/workshop-on-best-practices-of-climate-change-adaptation-in-the-wadden-sea-region-616

[53] http://www.waddensea-secretariat.org/tgc/documents

Adaptation strategies and plans

The North Sea Commission within CPMR (see Box 3.2) lobbied for the establishment of a North Sea macro-regional strategy, and encountered resistance from national governments. As a response, the North Sea Commission developed the North Sea Region 2020 strategy (2016), in which climate change adaptation is defined as one of the key areas for strategic action. The strategy recognises climate change risks for the regions, such as: sea level rise and increased coastal flooding as well as an increase of the burden on the marine ecosystem through water warming, acidification and the influx of new species. As an integration of the ongoing process of developing national adaptation strategies and plans, the strategy calls for a "*collaborative approach to address climate change in the common resource that is the North Sea*". Developing the knowledge base through joint research, sharing data, cross border studies, etc., will be paramount to the development of a common and innovative approach to adaptation and mitigation (CPMR North Sea Commission, 2016).

The Trilateral Wadden Sea Cooperation has adopted a trilateral strategy on increasing the resilience of the Wadden Sea to the impacts of climate change, in 2014.

3.5 Baltic Sea

INTERREG cooperation programmes

The INTERREG V B BSR Programme 2014–2020[54] (INTERREG BSR, 2015) supports integrated territorial development and cooperation for the Baltic Sea region. Further to environmental concerns related to the eutrophication of the sea basin, the current Baltic Sea INTERREG Programme (2014–2020) addresses climate change-related issues, by focusing, *inter alia*, on urban governance and adaptation in urban areas, which are defined as horizontal cross-cutting issues. The programme priorities relate to: a) water management for reduced nutrient inflows and decreased discharges of hazardous substances to the Baltic Sea and regional waters (objective 2.1); b) increase production and use of sustainable renewable energy (objective 2.2); c) energy efficiency (objective 2.3) and d) advancing sustainable and resource-efficient blue growth (specific objective 2.4). For that reason, it has been very difficult during the present programming period to finance transnational action, and the majority of transnational projects concerning adaptation are currently financed either under INTERREG CBC Programmes, such as the Central Baltic Programme (e.g. the Horizontal Action (HA) Climate Flagship project iWater – 'Integrated Storm Water Management' which aims to improve urban planning by developing integrated and multifunctional storm water management in the Central Baltic cities[55]) or by EC (e.g. the project CASCADE – climate change risk management at the local authority level in BSR, financed by the EC Directorate General for European Civil Protection an Humanitarian Aid Operations (DG ECHO).

The previous INTERREG programme 2007–2013[56] (INTERREG BSR, 2012) had four prioritised thematic areas focusing on innovation, accessibility, pollution and cooperation between metropolitan areas, cities and rural areas in order to increase attractiveness for investment. Its third priority focused on environmental pollution of the Baltic Sea in a broader framework of a sustainable management of the sea resources and specifically included adaptation to climate change.

[54] https://www.interreg-baltic.eu

[55] https://www.integratedstormwater.eu

[56] http://eu.baltic.net/Programme-document.98.html

EU macro-regional strategies

The EU Strategy for the Baltic Sea Region (EC, 2012b) was the first comprehensive EU strategy to target a 'macro-region' in Europe[57]. It aims to reinforce cooperation within the Baltic Sea region to promote more balanced development in the area, to contribute to major EU policies and to reinforce integration within the region.

Climate change was already a priority in the very first Action Plan of EUSBSR in 2009 (EC, 2009), when EUSBSR called for the development of a macro-regional approach to adaptation to climate change. In 2013–2014, climate change was incorporated in the HA 'Sustainable Development', and a HA Climate of the of EUSBSR was introduced in the 2015 revisions to the EUSBSR Action Plan[58]. Achievements so far have targeted environmental challenges in the region, especially connected to the reduction of nutrient loads and the increase of water quality, and succeeded in setting up activities which also include Russian partners. These activities aim to improve the environmental status in order to generate indirect benefits under changing climate conditions as eutrophication will generate higher negative impacts with increasing temperatures.

Conventions

The Convention on the Protection of the Marine Environment of the Baltic Sea Area, also known as HELCOM (1992) addresses climate change adaptation indirectly through environmental protection and sustainability. The convention is governed by the Baltic Marine Environment Protection Commission (HELCOM), which has a number of initiatives related to CCA, e.g. regular regional assessment of climate change and its implications for the Baltic Sea.

Other cooperation initiatives

The Council of the Baltic Sea States (CBSS)[59] is a political forum for intergovernmental cooperation in the Baltic Sea region. Founded in 1992, in the first instance it aimed to support the transition of the Baltic Sea region into the new international landscape after the end of the Cold War. Its current mission is to support 'a global perspective on regional problems', which includes the translation of international treaties as, among others, the UN Sustainable Development Goals, the Paris Climate Agreement, and the Sendai Framework on Disaster Risk Reduction, further to the EUSBSR strategy (8 of the 11 Member States of CBSS are also members of the EUSBSR strategy) into regional actions on the ground.

The organisation has an important function in the implementation process of EUSBSR. For example, in 2010 CBSS published a background paper on climate change, which reviewed many of the climate change actions on various levels that were happening around BSR. One of its final recommendations was to develop a BSR climate change adaptation strategy to "*rally efforts and resources around major challenges that would otherwise be too large for any single actor*" (Dis et al., 2010). The CBSS leads the HA Climate and has initiated BSR Climate Dialogue Platform (see section on adaptation planning below). This action also aims to evaluate the success of adaptation policies implemented by Member States and improve coordination and synergy among BSR initiatives and projects dealing with adaptation.

[57] https://www.balticsea-region-strategy.eu

[58] http://www.cbss.org/

[59] http://www.cbss.org/

The Union of the Baltic Cities (UBC) Sustainable Cities Commission is active through its policy areas focusing on climate change, including adaptation, which aims to strengthen the local levels through cooperation and networking.

Adaptation strategies and plans

The Baltadapt[60] project, which was financed under the INTERREG IV B Baltic Sea Programme 2007–2013, produced an adaptation strategy for the Region, which is accompanied by guidelines and an indicative action plan. The 2014 CBSS high level political meeting endorsed the adaptation strategy in the document 'Decision by the Council of the Baltic Sea States on a review of CBSS' long-term priorities' (CBSS, 2014). The Baltadapt Strategy for Adaptation to Climate Change for the Baltic Sea Region (Andersson, 2013) is one of the few examples of transnational adaptation strategies in Europe, and the only one developed within a transnational cooperation programme. It is accompanied by a non-binding action plan. The strategy intends to complement national and sub-national adaptation processes in the Baltic Sea region, in particular by improving coordination across levels and sectors by means of information sharing and development of networks. The Baltadapt strategy for Adaptation to Climate Change in the Baltic Sea Region has been integrated into the EUSBSR strategy, and the EUSBSR HA Climate aims to increase awareness and capacity for climate change adaptation in the region, focusing in particular on the local and regional level.

The CBSS established the BSR Climate Dialogue Platform, which aims to make regionally specific climate adaptation materials publicly available through the Climate-ADAPT platform and develop a joint capacity training and awareness raising project[61]**.** The BSR Climate Dialogue platform has been endorsed by the CBSS Foreign Ministers and holds regular meetings of representatives of national governments, the EC and BSR flagship projects to discuss the progress of implementation of the EUSBSR HA Climate and the BSR adaptation strategy, including annual work plans and monitoring. This round-table format, in conjunction with CBSS, tries to intermediate between levels and sectors, and represents the main multi-level governance mechanism for adaptation on transnational level in BSR.

However, a recent research project investigating the BSR adaptation strategy as a case study (Clar, forthcoming; Clar and Steurer, 2017) has also shed light on the difficulties that the implementation of such transnational adaptation policies encounters. As transnational structures are without any legal powers, CBSS and its BSR Climate Dialogue Platform have little formal leverage and are not in the position to shape adaptation at national or sub-national levels through binding requirements. Thus, transnational strategy coordinators have to rely on the force of argument to convince their Member States that they can offer added value to their respective (sub-) national policy processes. The transnational strategy process offers support to the adaptation efforts of the national states through provision of knowledge, recommendations, access to funding and networking, but has to avoid patronising the Member States. National governments are perceived as the major drivers of the transnational governance process, but this also makes transnational actors dependent on the continuous support and political will of their Member States (Clar and Steurer, 2017; Clar, forthcoming). A lesson to be learnt from the Baltic case study may be that more clearly defined roles for transnational adaptation strategies would give transnational actors more leeway, and that their implementation could benefit

[60] www.baltadapt.eu

[61] http://www.cbss.org/strategies/horizontal-action-climate/

from stronger institutionalisation of multi-level coordination mechanisms. On the other hand, the case also shows that rather informal governance formats like the BSR Climate Dialogue Platform can play an important role in compensating for the lack of formalised transnational coordination mechanisms by acting as intermediaries between levels and sectors.

3.6 Alpine Space

INTERREG cooperation programmes

Climate change is repeatedly identified as a main driving force and a specific challenge for the Alps in the current INTERREG V B Alpine Space Programme (ASP) 2014–2020 (INTERREG ASP, 2014). However, adaptation is not addressed as an objective *per se*, but as a horizontal theme and an issue to be mainstreamed in every project. A series of climate adaptation projects has been approved in the previous funding period (2007 – 2013), and thus the programme considers adaptation to be at a mature stage of the policy cycle already. Adaptation as a cross-cutting issue is explicitly mentioned in several themes, including biodiversity, ecosystem services, risk prevention, ecological connectivity, and use of natural resources, under priority 3 'Liveable Alpine Space', which targets environmental protection and resource efficiency. The Alpine Space Programme supports the EUSALP implementation process, including its Action Group 8 on risk management and climate adaptation, by granting project-based funding for its governance structure through the running AlpGov[62] project as well as by requiring regular project applications to address priorities and support activities of thematic EUSALP working bodies.

In the previous Alpine Space Programme 2007–2013 (INTERREG ASP, 2007), coping with the effects of climate change in all aspects was defined as a main objective of priority axis 3 'Environment and risk prevention', and a specific objective addressed the prevention and mitigation of natural hazards and their consequences in the explicit context of climate change impacts. In that period, the Alpine Space Programme co-funded a significant number of projects on climate change impacts and adaptation options with an accumulated budget of about EUR 25 million, corresponding to approximately 5% of the programme budget (Gonzales, 2017).

EU macro-regional strategies

Allocated to thematic objective 3 'Environment and energy' of EUSALP[63] and bundled together with risk management, adaptation is one of two core topics within EUSALP AG8 (Action Group on Risk Governance) "*to improve risk management and to better manage climate change, including major natural risks prevention*"[64]. The common objective of the current medium-term work plan (up to mid–2019) of AG8 is to map, analyse and enhance governance mechanisms in the fields of natural hazard management and adaptation to climate change, including enhanced coherence between both policy fields. The planned outputs are studies, good practice examples and policy enhancement options on risk governance, adaptation governance, and mainstreaming of climate adaptation and disaster risk reduction, aiming to pave the way for more effective and better aligned governance approaches in the Alpine macro-region. A further goal of AG8 is to deploy, advance and maintain the transnational online portal CAPA – Climate Adaptation Platform for the Alps[65] (developed within the Alpine Space project C3-

[62] http://www.alpine-space.eu/projects/alpgov/en/home and http://www.alpine-region.eu/projects/alpgov

[63] http://www.alpine-region.eu/

[64] https://www.alpine-region.eu/action-group-8

[65] http://www.capa-eusalp.eu/

Alps[66] in the previous programming period) under the umbrella of EUSALP (see section 4.2). Like other Action Groups, AG8 collaborates with running projects funded by the Alpine Space programme, including the GoApply project[67] (see section 4.1.6). The EUSALP Action Plan (EC, 2015a) encourages, among others, the development of an Alpine adaptation strategy and action plan based on a comprehensive vulnerability assessment and in line with the existing national adaptation strategies, but this recommendation has not yet been taken up. Climate change impacts and adaptation are also linked to the themes of ecological connectivity and natural resources, including water and soil management, and cross-sectoral issues related to adaptation (e.g., green infrastructure, droughts, water demand and supply management) are to some extent addressed by the activities of corresponding Action Groups.

Conventions

Although there is not a thematic protocol on climate change, climate change and adaptation have for years been a field of work within the Alpine Convention. The Alpine Conference adopted a Declaration on Climate Change in 2006 (Alpine Convention, 2006), which was made more specific in the Climate Change Action Plan adopted in 2009 (Alpine Convention, 2009), addressing both mitigation and adaptation. Taking action on climate change is one of 6 priorities of the multi-annual work programme 2017–2022[68]. The Contracting Parties, the observers, and the thematic working bodies of the Convention[69] regularly work on cross-sectoral aspects of adaptation and have produced a range of specific transnational outputs, including statements and guidelines, workshops, and experimentation projects, often contributing to implementation of actions laid down in the Climate Action Plan. The Alpine Climate Board (ACB)[70] was established in 2016 and is currently adding detail to proposals for an Alpine-wide Climate Target System. The Convention has a well-established transnational observer network that comprises a large number of relevant governmental and non-governmental umbrella organisations that are active in the Alpine Convention's fields of activity[71], including climate adaptation. Overall, the integration of adaptation into the Alpine Convention and its related treaty-based processes has strengthened transnational adaptation efforts (EEA, 2014).

Other cooperation initiatives

A transnational network of the national adaptation policymakers of the Alpine countries has been established in the frame of the INTERREG Alpine Space project C3-Alps[72] from 2012 onwards, as an informal platform for regular knowledge exchange and joint learning between countries about adaptation policy making, implementation of adaptation strategies and common governance challenges. The members are the national public authorities (national ministries and/or agencies) responsible for the national adaptation strategies/action plans and in charge of coordinating their implementation.

The Alpine region is characterised by a long tradition of transnational cooperation and a high density of cooperation structures with mutual relations. Institutional and actor-based linkages and consultation

[66] http://www.alpine-space.org/2007-2013/projects/projects/detail/C3-Alps/show/index.html

[67] http://www.alpine-space.eu/projects/goapply/en/home

[68] http://www.alpconv.org/en/convention/workprogramme/default.html

[69] http://www.alpconv.org/en/organization/groups/default.html

[70] http://www.alpconv.org/en/organization/groups/alpineclimateboard/default.html

[71] http://www.alpconv.org/en/organization/observers/default.html

[72] http://www.alpine-space.org/2007-2013/projects/projects/detail/C3-Alps/show/index.html

mechanisms between the three main transnational cooperation entities, i.e. the Alpine Space Programme, EUSALP, and the Alpine Convention, are in place and are being further developed. For instance, EUSALP and Alpine Convention have granted the chairs of their bodies reciprocal observer status in each other's institutional meetings, and two exchange workshops in 2017 and 2018 laid the ground for strategic coordination of thematic work processes. This also holds potential for future transnational cooperation on adaptation.

Transnational cooperation and knowledge exchange is in some Alpine countries defined as a goal or principle in the national adaptation strategies, e.g. most explicitly in the Swiss strategy document[73]. Also, the national adaptation strategies of some countries reference outcomes of transnational cooperation projects as part of their respective knowledge base (BMLFUW, 2012, 2017).

Adaptation strategies and plan

The Alpine Convention's Action Plan on Climate Change in the Alps (Alpine Convention, 2009) is to date the only politically relevant transnational policy document on adaptation in place in the Alpine region. It covers both adaptation and mitigation and has been adopted by political resolution but has no legally binding status. Although its overall impact on policymaking and practice in the Alpine countries may be regarded as rather moderate, some of its recommendations for action have since then been taken up by the mandates of several of the Convention's thematic working bodies.

Established by the Alpine Conference in 2016 to bundle together relevant climate change activities carried out in the framework of the Alpine Convention, the Alpine Climate Board[74] is currently working on a system of objectives for climate-neutral and climate-resilient Alps. The Climate Target System along with recommendations will be submitted for adoption to the XV Alpine Conference in April 2019. It is expected that future activities under the climate change priority of the multi-annual work programme 2017–2022 will focus on implementing these targets. For that purpose, design of the target system will allow monitoring and evaluation of progress at least in qualitative terms.

INTERREG Alpine Space projects regularly produce transnational outputs, such as adaptation-related strategy papers, concepts, principles or work aids for adaptation planning on (sub)national levels, but these products represent expert recommendations without direct political relevance. They may often play an enabling role for adaptation policymaking in countries and regions, but policy uptake is usually not straightforward and is difficult to track.

3.7 Central Europe

INTERREG cooperation programmes

The current INTERREG V Central Europe Programme 2014–2020[75] (INTERREG Central Europe, 2016) highlights climate change impacts, in particular an increasing number of extreme weather events, natural hazard events, and changes in geographic distribution of precipitation, as major challenges for

[73] Principle 8 of the Swiss Strategy for Adaptation to Climate Change: "*Switzerland participates in international exchange of experiences on adaptation to climate change. It uses the knowledge and experiences of other countries and, at the same time, provides its own knowledge and experiences to other countries. In case of transboundary issues, Switzerland coordinates its actions with neighbouring countries*" (BAFU, 2012).

[74] http://www.alpconv.org/en/organization/groups/alpineclimateboard/default.html

[75] http://www.interreg-central.eu/

the region. Despite this, no separate priority axis or related funding objective is specifically dedicated to adaptation to climate change. The programme addresses adaptation as one among several environment-related sub-topics within priority 3 on 'Natural and cultural resources for sustainable growth in the region'. Adaptation is covered there in a specific objective that aims to improve integrated environmental management capacities for the protection and sustainable use of natural heritage and resources. Climate change and increasing risks of natural hazards linked to the effects of climate change are addressed in that context as one among many other pressures on natural resources. In addition, vulnerability of urban areas to climate change is identified as an issue under a further objective on "*the improvement of environmental management of functional urban areas to make them more liveable places*".

In the former Central Europe Programme 2007–2013 (INTERREG Central Europe, 2007), climate adaptation was allocated to the theme 'Environmental management and climate change' under priority 3 ('Using our environment responsibly', sub-themes 'Cooperating to prevent environmental hazards and to reduce the negative effects of climate change' and 'Cooperating to protect and preserve nature and landscapes').

EU macro-regional strategies

There is no directly corresponding EU macro-regional strategy for the Central Europe region, but several macro-regional strategies have a share in different parts of the Central European cooperation area, as defined by the respective INTERREG programme. These are EUSDR, EUSALP and EUSAIR, which are dealing with climate adaptation on their transnational cooperation agendas in various ways (see sections 3.8 on Danube, 3.6 on Alpine Space and 3.11 on Adriatic-Ionian). The INTERREG Central Europe Programme contributes to all these macro-regions, but EUSDR has the largest geographical overlaps with the Central Europe region and is thus most relevant.

Conventions

Transnational cooperation activities relevant to climate change and adaptation within the frame of the Carpathian Convention[76] and the Danube River Protection Convention (DRPC)[77] are described in the section on the Danube region (see section 3.8, Danube Region). Although the perimeters of both conventions partially overlap with Central Europe, they are almost entirely included in the Danube transnational region.

Adaptation strategies and plans

Existing transnational and cross-border strategies and plans addressing adaptation concerns relevant to parts of the Central Europe region have an overriding focus on water resource and flood risk management in the Danube river basin. The Strategy on Adaptation to Climate Change (ICPDR, 2012) of the International Commission for the Protection of the Danube River (ICPDR)[78] as well as the relevance of the Danube River Basin Management Plan (DRBM Plan) and the Danube Flood Risk Management Plan (DFRM Plan) for adaptation are thus described in the section on the Danube region (see section 3.8, Danube Region).

[76] http://www.carpathianconvention.org/

[77] https://www.icpdr.org/main/icpdr/danube-river-protection-convention

[78] http://www.icpdr.org/main/

3.8 Danube

INTERREG cooperation programmes

As water represents an essential resource for the region, the INTERREG V B DTP 2014–2020 (INTERREG Danube, 2017) deals with challenges related to climate change mainly in the context of transnational water management, flood management and risk management. Climate adaptation and DRR are not dedicated thematic objectives, but they are explicitly considered under priority 2 on 'Environment and culture', corresponding to the programme's thematic objective on 'Environment and resource efficiency' (TO6). The main cooperation needs include the international coordination of policies related to water management within the framework of the Danube River Basin Management Plan (ICPDR, 2015b), the creation of efficient, transnational disaster management systems, and the development of transnational strategies and action plans to manage the challenges represented by climate change. Programme interventions under TO6 are expected to focus on water management, the control of environmental risk factors such as climate change and flood risks, and on disaster risk reduction, including in relation to changing climate conditions. Contribution to enhanced awareness of adaptation to climate change and risk prevention is included among the projects' selection criteria. DTP is the most important funding instrument for transnational cooperation projects supporting implementation of EUSDR.

Although in the previous INTERREG SEE Programme 2007–2013[79] climate change was not explicitly addressed as an area of intervention, adaptation was inherently covered within priority axis 2 'Environment' in the context of the themes integrated water management and flood risk prevention, prevention of environmental risks, and management of natural assets. Despite the difference in territorial scope to the current DTP 2014–2020, a number of countries from the Danube region were involved in projects relevant to adaptation co-funded by the SEE 2007–2013 Programme[80]. SEE 2007–2013 co-funded 7 projects relevant to climate adaptation with a total funding volume of about EUR 18 million, representing a share of 4% of the entire programme budget (Gonzales, 2017).

EU macro-regional strategies

The EU Action Plan (EC, 2010a) for EUSDR (EC, 2010b) has addressed climate change impacts on extreme weather events (floods, drought, forest fires, storms, erosion, icing, water scarcity), hydrological cycles, precipitation patterns and water level variations, which affect water management throughout the Danube basin in manifold ways. Among the 11 priority areas of EUSDR, climate change impacts and climate adaptation issues prominently feature in the environmental pillar of the Strategy, which is composed of priority area 4 'To restore and maintain the quality of waters' (PA4), 'To manage environmental risks' (PA5) and 'To preserve biodiversity, landscapes and the quality of air and soils' (PA6). Among these, PA5[81] up to now has the highest relevance to adaptation. Targets defined in PA5 include addressing the challenges of water scarcity and droughts, and supporting implementation of the Danube Flood Risk Management Plan, taking into account the potential impacts of climate change and adaptation strategies.

[79] http://www.southeast-europe.net/en/

[80] http://www.southeast-europe.net/en/projects/approved_projects/

[81] https://www.danubeenvironmentalrisks.eu/

The EUSDR Action Plan (EC, 2010a) encourages actions related to adaptation within PA5 with the following foci: transboundary flood risk management plans at basin level, wetland and floodplain restoration (as a means of passive flood protection and in the context of green infrastructure), transboundary flood alert systems, transnational cooperation of emergency response authorities, research on regional and local impacts of climate change as well as climate- and flood-proof spatial planning and construction activities.

The current work programme of PA5 for 2017–2019 includes activities that contribute to the development of an update of the ICPDR Strategy on Adaptation to Climate Change (ICPDR, 2012). Apart from the environment-related priority areas, the Danube Strategy recognises that climate change and adaptation also have impacts on many sectors and policy fields. It thus encourages an integrated approach, including the consideration of adaptation aspects in all relevant priority areas.

The EUSDR implementation process and the INTERREG Danube Programme are strategically aligned on several levels. Firstly, DTP provides financing to the EUSDR governance process and the coordination activities of priority area coordinators, and thus supports execution of their respective work programs. Secondly, mechanisms are in place to ensure that DTP-funded projects are in line with goals pursued by the priority areas of EUSDR: project applications to DTP have to address objectives and actions of the EUSDR Action Plan; priority area coordinators are involved in the evaluation of project proposals and are entitled to issue recommendations; and often projects are developed by members of priority areas. The work of PA5 of EUSDR, and thus activities relevant to adaptation, benefit from these cooperation mechanisms.

Due to geographic overlaps with other macro-regions, also EUSALP and EUSAIR (see sections 3.6 and 3.11, respectively) are to some extent relevant for transnational cooperation on adaptation in the Danube region.

Conventions

The main objective of the Danube River Protection Convention (ICPDR, 1994), as the overall legal instrument for cooperation on transboundary water management in the Danube River Basin, is to ensure that surface waters and groundwater within the Danube River Basin are managed and used sustainably and equitably. The signatories have agreed to co-operate on fundamental water management issues by taking "*all appropriate legal, administrative and technical measures to at least maintain and where possible improve the current water quality and environmental conditions of the Danube river and of the waters in its catchment area, and to prevent and reduce as far as possible adverse impacts and changes occurring or likely to be caused*" (ICPDR, 1994 Article 2). The Convention addresses issues related to climate change in an indirect way by aiming at, *inter alia*, the conservation, improvement and rational use of surface waters and groundwater as well as at preventive measures to control hazards originating from accidents involving floods. An *ad hoc* commission, the International Commission for the Protection of the Danube River (ICPDR) [82] has been created for coordinating the implementation of the convention. It has also been tasked by the Ministers of the Danube countries to act as the platform for coordinating the implementation of the EU Water Framework Directive (EU, 2000) in the Danube River Basin.

[82] http://www.icpdr.org/main/

In February 2010, Ministers and high-level representatives responsible for water management in the Danube countries and from the EU endorsed the 'Danube Declaration'[83] (ICPDR, 2010), which expresses the commitment to further reinforce transboundary cooperation on sustainable water resources management within the Danube River Basin and emphasises that adaptation measures are needed to avoid significant threats from climate change impacts. In order to take the required steps, the International Commission for the Protection of the Danube River was asked by the signatories to DRPC to develop a Climate Adaptation Strategy for the Danube River Basin, which should ensure that measures and projects are climate proof, and that adaptation issues were fully integrated into updates of the Danube River Basin Management Plan. The second Danube Declaration adopted in 2016 (ICPDR, 2016) appreciates the groundwork done on climate change and adaptation and mandates ICPDR to foresee an update of its adaptation strategy in time for the next planning cycle of the EU Water Framework Directive (EU, 2000) and the EU Floods Directive (EU, 2007).

The Carpathian Convention[84] (2003) is a sub-regional treaty to foster the sustainable development and the protection of the Carpathian region and the only multi-level governance mechanism covering the whole of the Carpathian area. At the 5th Conference of Parties (COP) in 2017, the parties agreed to adopt the new Article 12bis on 'Climate Change' in the convention. Therein, the Parties agree to "pursue policies aiming at climate change adaptation […], and foster local adaptation planning processes and the implementation of actions, especially in the most vulnerable areas and sectors, and to undertake integrated measures to reduce the risks and minimise the adverse effects of climate change, especially of extreme weather events" (SCC, 2017). There are no sectoral strategies on adaptation to climate change in the Carpathian Convention. However, the Protocol on Sustainable Forest Management (Carpathian Convention, 2011) requires parties to integrate sustainable forest management in other policies, including climate change, and to adopt national measures to prevent floods and other extreme events specifically concerning adaptation (Alberton et al., 2017).

The Carpathian Convention first addressed climate change in 2008 in water and integrated river basin management. In 2011, the Convention established the Working Group on Adaptation to Climate Change to collect information and data on climate change, promote regional cooperation on adaptation in the mountains and develop joint projects. In 2014, the Strategic Agenda on Adaptation to Climate Change in the Carpathian Region was adopted in 2014 (Alberton et al., 2017). It includes recommendations for policy, institutional change and potential priority adaptation actions, and it calls upon countries, local and regional authorities, and other stakeholders to formulate policies and design strategies to adapt to climate change. Giving attention to climate change is one of the priorities of the current Hungarian presidency (until 2020) of the Carpathian Convention.

Other cooperation initiatives

In the field of water management, cooperation between Danube countries is already well advanced, mainly through the inter-governmental work under the umbrella of the International Commission for the Protection of the Danube River (ICPDR) and the International Sava River Basin Commission (ISRBC). Examples of efforts in joint management of shared resources under the umbrella of EUSDR and with funding from different sources, including the INTERREG DTP in the frame of projects, include:

[83] http://www.icpdr.org/main/sites/default/files/Ministerial%20Declaration%20FINAL.pdf

[84] http://www.carpathianconvention.org/

development of a water and climate adaptation plan for the Sava River Basin (World Bank, 2015); implementation of transboundary flood alert, risk management and rapid response mechanisms along the Danube basin as well as transboundary floodplain and wetland restoration, aiming also at flood prevention. The latter implementations were mostly realised gradually with the support of several subsequent INTERREG programmes.

In order to improve the coordination of all transboundary water management activities in the Danube River Basin, ICPDR and EUSDR (PA4 and PA5 coordination) elaborated and agreed on the 'Joint Paper on Cooperation and Synergy for EUSDR Implementation' in 2014 (EUSDR and ICPDR, 2014). This agreement between the two transnational cooperation structures, who are both dealing with water management issues in the Danube region on the basis of different mandates, followed a period of rather difficult relationships. The main goal of the joint agreement was to avoid duplications and overlaps and to reinforce synergies between the work of both entities. Based on common cooperation principles, the agreement has succeeded in establishing a culture of close collaboration and, more specifically, increased the capacities for CCA and DRR in the region, as is illustrated by the following example: EUSDR results, including from a basin-wide survey on operative needs in flood management carried out by PA5, have been incorporated in the Danube Flood Risk Management Plan. A specific input of EUSDR on the improvement of flood forecasting evolved into the DAREFFORT (Danube River Basin Enhanced Food Forecasting Cooperation[85]) project (2018–2021) funded by the DTP programme. This project aims to deliver the groundwork for establishing a future transboundary hydrological information system (DanubeHIS), which will be operated by ICPDR.

Adaptation strategies and plans

In response to the mandate given by the Danube Declaration (ICPDR, 2010), and building on groundwork provided by the 'Danube Study – Climate Change Adaptation' (BMUB et al., 2012), the Strategy on Adaptation to Climate Change of the International Commission for the Protection of the Danube River (ICPDR, 2012) was adopted in December 2012. It provides the knowledge base and a strategic framework for integrating adaptation of the water sector to climate change into the implementation of the EU Water Framework Directive (EU, 2000) and the EU Floods Directive (EU, 2007).

On a more operational level, this is done by mainstreaming adaptation into the Danube River Basin Management Plan (DRBM Plan) and the DFRM Plan. Already the 1st Danube River Basin Management Plan (ICPDR, 2009), which was adopted by ICPDR in 2009, included initial conclusions on the need for climate adaptation and risk management. In 2015, ICPDR adopted the revised Danube River Basin Management Plan (DRBM Plan) (ICPDR, 2015b), an accompanying Joint Programme of Measures, and the 1st DFRM Plan (ICPDR, 2015a)[86]. These two plans set the water management priorities for the Danube River Basin until 2021. Adaptation to climate change has been incorporated as an integrative principle for river basin management into both instruments, and the updated DRBM Plan also contains a first assessment of the relevance of water scarcity and drought issues in the Danube basin. The Danube countries have endorsed both documents and committed to implement the measures (ICPDR, 2016). Full implementation of the DRBM Plan is an integral part of the EUSDR Action Plan, and the DRBM Plan is a main information source for prioritising and granting funding of measures in the Danube region.

[85] http://www.interreg-danube.eu/approved-projects/dareffort

[86] http://www.icpdr.org/main/management-plans-danube-river-basin-published

An update of the ICPDR Strategy on Adaptation to Climate Change (2012) is planned for 2018. The updated and revised strategy will be taken into account for the planning process of the 3rd DRBM Plan and the 2nd DFRM Plan, due by 2021. The EUSDR supports the 2018 update of the ICPDR Adaptation Strategy through activities under the current work programme 2017–2019 of Priority Area 5 (PA5).

EUSDR projects, regularly co-funded by the INTERREG B Danube Transnational Programme, have been conducted on completing and supporting adoption of Danube Tributaries' River Basin Management Plans and of a Management Plan for the Danube Delta.

Based on the Strategic Agenda on Adaptation to Climate Change in the Carpathian Region, the Carpathian Convention Adaptation to Climate Change Working Group started to work on the development of an action plan. This work is currently on hold, due to the lack of funding for the activity.

3.9 Mediterranean

INTERREG and ENI CBC cooperation programmes

The INTERREG V B MED Programme 2014–2020 (INTERREG Mediterranean, 2016)[87] aims to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices (technologies, governance, innovative services). It also encourages the sustainable use of natural and cultural resources and support social integration, through an integrated and territorially based cooperation approach. For the period 2014–2020 the MED programme is structured along four axis: (1) Promoting Mediterranean innovation capacities to develop smart and sustainable growth, focusing on blue growth, green growth and social innovation, cultural and creative industries; (2) Fostering low carbon strategies and energy efficiency in specific MED territories (cities, islands and remote areas), focusing on energy efficiency in public buildings, renewable energy and low carbon urban transport; (3) Protecting and promoting Mediterranean natural and cultural resources, focusing on sustainable maritime and coastal tourism and biodiversity protection; (4) Enhancing Mediterranean governance. The MED Programme 2014–2020 (INTERREG Mediterranean, 2016) makes explicit references to climate change adaptation and risk management under the priority axis 2. Adaptation is also included in the possible foci of the funded projects, as well as the areas to which the projects will contribute. For example, under axis 3, the 'Biodiversity protection' thematic aims to strengthen the management capacities of protected areas to adapt and improve protection measures, therefore also creating a link to climate change adaptation.

In the previous programming period[88], climate change was addressed under axis 2 'Environmental protection and promotion of a sustainable territorial development' which included four objectives: (2.1) Protection and enhancement of natural resources and cultural heritage; (2.2) Promotion of renewable energies and energy efficiency improvement; (2.3) Prevention of maritime risks and strengthening of maritime safety; (2.4) Prevention of and fight against natural risks. For example, the first objective included strategies to anticipate and adapt to climate changes among possible actions, while objective 2.4 also considered new strategies and planning techniques to cope with climate change effects on forest fires.

[87] https://interreg-med.eu/

[88] http://www.programmemed.eu/en

Considering that the Mediterranean region includes a relevant number of non-EU countries, following the previous ENPI CBC Programme 2007–2013, the EU launched the ENI CBC Mediterranean Sea Basin 2014–2020 Programme[89]. This programme provides the framework for the implementation of cross-border cooperation activities in the context of the European Neighbourhood Policy, with the final aim of developing an area of peace, stability, prosperity and good neighbourliness involving both EU Mediterranean Countries (EUMC) and Mediterranean Partner Countries (MPCs). The strategy of the Joint Operational Programme is structured in two overarching objectives ('Promote economic and social development' and 'Address common challenges in environment') split into four thematic objectives. Specifically, the second overarching objective includes the specific objective 'Environmental protection, climate change adaptation and mitigation', whose priorities are related to: efficiency in water and waste management, renewable energy and energy efficiency and Integrated Coastal Zone Management (ICZM).

EU macro-regional strategies

Parts of the Mediterranean region overlap with the geographic scope of some EU macro-regional strategies; the most relevant for the Mediterranean being EUSAIR on the Adriatic-Ionian region; and to a much smaller extent the EUSALP strategy which includes the French Alps Maritimes the northern Regions of Italy and Slovenia.

Conventions

The United Nations Environment Programme Mediterranean Action Plan for the Barcelona Convention (UNEP/MAP)[90] was adopted in 1975, and is a regional cooperative effort involving 21 countries bordering the Mediterranean Sea, as well as the EU. Through UNEP/MAP, the contracting parties to the Barcelona Convention and its protocols aim to meet the challenges of protecting the marine and coastal environment while boosting regional and national plans to achieve sustainable development. The Marrakesh Declaration (UNEP/MAP, 2009) adopted in 2009 aimed to promote Mediterranean cooperation to combat the effects of climate change in the region and to implement effective coordination to ensure the integration of climate change issues into development policies and ensure the strengthening of cooperation for the sharing of experience in the field of surveillance (early-warning systems) and the development and implementation of adaptation and risk management strategies.

The UNEP/MAP Mediterranean Strategy for Sustainable Development (MSSD) was adopted in 2005, for the period 2005–2015. The contracted parties to the Barcelona Convention, UNEP/MAP and its Regional Activity Centres (RACs) and the Mediterranean Commission on Sustainable Development (MCSD) reviewed it in 2014–2015, and in 2016 adopted the MSSD 2016–2025 (UNEP/MAP, 2016a). This Strategy provides a strategic policy framework for securing a sustainable future for the Mediterranean region consistent with the Sustainable Development Goals (SDGs). The Strategy focuses on cross-cutting objectives that lie in the interface between environment and development. 'Addressing climate change as a priority issue for the Mediterranean' is one of the MSSD 2016–2025 objectives; climate change adaptation is included in a wide number of actions as part of the four strategic directions related to this objective.

[89] http://www.enpicbcmed.eu/

[90] http://web.unep.org/unepmap/

In 2008, a Protocol on Integrated Coastal Zone Management (ICZM Protocol) to the Barcelona Convention was developed to provide a common framework for the Contracting Parties to promote and implement ICZM. This Protocol includes actions which are also beneficial for climate change adaptation along the coastal system. Particularly important is article 8 of the protocol, the so-called 'setback article' which invites countries to establish in coastal zones, behind the highest winter waterline, a zone where construction is not allowed (UNEP/MAP/PAP, 2008). On the 13th September 2010, the EU Council adopted the decision to ratify the ICZM Protocol (EU, 2010), which thus entered into force in March 2011. The UNEP/MAP Priority Actions Programme Regional Activity Centre (PAP/RAC)[91], established in 1977, provides support for the implementation of the ICZM Protocol for the Mediterranean and MSSD, taking also climate change adaptation into account (see, for example, UNEP/MAP/PAP, 2015). Through ICZM, PAP/RAC also contributes to the implementation of the contents of the 'Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas' endorsed in 2016, which is further described in the following paragraph focused on initiatives related to adaptation strategies and plans.

Other cooperation initiatives

The Union for the Mediterranean (UfM)[92] is a multilateral partnership created in 2008 and consisting of the 28 EU Member States and 15 other Mediterranean partner countries. Among its diverse interests and activities, UfM aims to act as a unique platform to facilitate and promote regional dialogue and cooperation as well as concrete projects and initiatives in the fields of energy and climate action. In 2014 UfM established a 'Climate Change Expert Group'[93] to foster the exchange of information and best practices across the entire Mediterranean region, as well as to promote the development of concrete projects and initiatives (UfM, 2014).

The WESTMED Maritime Initiative[94] on the Western Mediterranean region involves the 10 countries of the 5 + 5 Dialogue (Algeria, France, Italy, Libya, Malta, Mauritania, Morocco, Portugal, Spain and Tunisia). The initiative identifies three main goals: (1) a safer and more secure maritime space; (2) a smart and resilient blue economy; (3) better governance of the sea. Climate change adaptation is mentioned within the second objective and refers to the development of tailor-made solutions and new technologies to harness marine renewable energies, to mitigate and adapt to climate change as well as to promote energy efficiency and adaptation to climate change in coastal cities (EC, 2017). Political coordination of the initiative will be provided by the Union for the Mediterranean, while operational coordination will be ensured through a WESTMED Task Force linked to the UfM Working Group on the Blue Economy.

Transnational cooperation on climate change adaptation in the region is also promoted through the Bologna Charter[95]. This is a policy document and initiative which aims to strengthen the role of coastal regional administrations in the context of European policies and initiatives at the Mediterranean scale related to: coastal protection, integrated management and adaptation to climate change. The charter also promotes and outlines a macro-project initiative for the current programming period of the

[91] http://www.paprac.org/

[92] http://ufmsecretariat.org/

[93] http://ufmsecretariat.org/ufm-climate-change-expert-group/

[94] http://www.westmed-initiative.eu/

[95] http://www.bolognacharter.eu/

European Structural Funds (2014–2020), designed for a coherent Mediterranean macro-thematic and multi-sectoral strategy. The macro-project is detailed in the Joint Action Plan (Bologna Charter, 2014).

Adaptation strategies and plans

Adaptation strategies and plans have not been developed for the Mediterranean in the frame of the INTERREG transnational cooperation or other forms of cooperation. However, the 19th meeting of Contracting Parties of the Barcelona Convention endorsed the 'Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas' (UNEP/MAP, 2016b). The document aims to build a common regional strategic approach to increasing climate resilience and adaptation capacity. The framework focus is on four strategic policy areas: (1) creating the necessary institutional and policy frameworks for adaptation policies, (2) development of best practices, (3) improving and enhancing access to relevant finance mechanisms, and (4) improving the scientific knowledge base for informed decision-making. Contracting Parties are urged to translate the framework into actions, to take it into account and address it in their national and local integrated coastal zone management and climate change adaptation strategies and plans.

3.10 South West Europe

INTERREG cooperation programmes

The INTERREG V B SUDOE Programme for the period 2014–2020 (INTERREG SUDOE, 2017) co-funds projects among five priority axes for transnational cooperation: (1) Research and innovation; (2) Competitiveness of small and medium enterprises (SMEs); (3) Low-carbon economy; (4) Combatting climate change; (5) Environment and resource efficiency. Priority axis 4 is endowed with 12% of the overall programme funding (EUR 17.08 million) and focuses on management and prevention of climate change risks associated with the scarcity of water resources and high variability of rainfall, which highlights the intensification of drought conditions, desertification, soil erosion, forest fires and flooding. Eligible projects include the development of common emergency plans; implementing early warning systems; the development of transnational risk management tools; and the creation of tools and methodologies for the regeneration of soil damaged by natural disasters.

The previous INTERREG SUDOE Programme (2007–2013) aimed to consolidate cooperation in the transnational region in the fields of competitiveness, innovation, environmental protection, sustainable planning and development. Four projects were approved under the theme 'Climate', three of them specifically focusing on climate change adaptation.

CBC also plays an important role in promoting and implementing adaptation initiatives in the whole SUDOE region. The INTERREG A Programme Spain–France–Andorra (POCTEFA) focuses on climate change-related issues in the thematic axis 2, aimed at promoting climate change adaptation, and 3, focusing on risk prevention and management. Both under the previous (2007–2013) and current programming periods, POCTEFA has provided financial support for the research activities of OPCC (see section 4.2). Similarly to POCTEFA, the cooperation programme Spain-Portugal (POCTEP) aims to promote climate change adaptation and disaster risk reduction and management under the heading of 'Sustainable growth'.

Finally, and as discussed for the Mediterranean region, the ENI CBC MED 2014–2020 features as an important cooperation instrument for promoting environmental protection and climate change adaptation in the region, especially with respect to water efficiency and coastal area conservation.

Other cooperation initiatives

The Pyrenees have a long tradition of cooperation. The CTP[96] was established in 1983 on the initiative of the Council of Europe to tackle common cross-border challenges in the fields of transports, education, research, cultural heritage and sustainable development, among others. In 2010, CTP funded OPCC with the aim of promoting a better understanding of climate change impacts in the region and defining effective adaptation measures (reference to relevant part in section 4.2).

Other relevant initiatives on adaptation which partly overlap with the SUDOE region include the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR, 2010) and UNEP/MAP (UNEP/MAP, 2016b). Both are treated in greater detail in the Atlantic and Mediterranean region sections respectively. The WESTMED Maritime Initiative on the western Mediterranean region (EC, 2018e), funded by the EC and carried out in close cooperation with relevant stakeholders, is also worth mentioning for the attention devoted to the promotion of climate change adaptation in coastal cities (see Mediterranean region section 3.9 for more details).

Adaptation strategies and plans

Parts of the SUDOE region overlap with territories covered by the Atlantic Maritime Strategy and related action plan (EC, 2011a, 2013a see Section 3.2). The latter identifies the development of better predictive and risk assessment capabilities, as a way to protect marine waters and coastal zones (see Atlantic Area section 3.2 for more details). Neither have climate change adaptation plans been set up for this region nor do policy-related cooperation initiatives with relevance for climate change adaptation exist.

3.11 Adriatic-Ionian

INTERREG cooperation programmes

The INTERREG V B ADRION Programme (INTERREG ADRION, 2015)[97] covers the entire area of EUSAIR. For the period 2014–2020 ADRION focuses on four priority axes: (1) Innovative and Smart Region; (2) Sustainable Region; (3) Connected Region; (4) Supporting the governance of EUSAIR. These four priorities aim to work towards: (1) Strengthening research, technological development and innovation; (2) Preserving and protecting the environment and promoting resource efficiency; (3) Promoting sustainable transport and removing bottlenecks in key network infrastructure; (4) Enhancing the institutional capacity of public authorities and stakeholders, and efficient public administration.

Climate change adaptation is considered under priority axis 2, as part of the Specific Objective 2.2 ‘Enhance the capacity in transnationally tackling environmental vulnerability, fragmentation and safeguarding ecosystem service in the ADRION area’. Through this objective ADRION is expected to contribute to enhancing common understanding in the region on environmental protection, biodiversity management, ecosystem services and climate change adaptation. Other expected results include: enhanced competencies of stakeholders and involved partners; increased availability of data and information also through interoperability and systematic monitoring; increased transnational cooperation among authorities and civil society organisations; harmonised infrastructure, management

[96] https://ctp.org/

[97] http://www.adrioninterreg.eu/

structures and hazard or risk response mechanisms; increase in the number of management and planning tools.

ADRION is a new cooperation programme and substitutes two previous INTERREG Programmes active in the period 2007–2013. The SEE programme (European Territorial Co-operation, 2013) was a funding instrument focused on a wide area involving 16 participating countries in total[98], including all eight ADRION countries. SEE also overlapped with further two new INTERREG V 2014–2020 programmes, i.e. Danube (see section 3.8) and Balkan-Mediterranean (see section 3.12). As described in section 3.8, climate change was inherently covered by the SEE Operational Programme under axis 2 'Environment', in the context of integrated water management, transnational flood risk prevention, and prevention of other climate-related risks (e.g. droughts and fire).

The Adriatic IPA Cross-Border Cooperation Programme 2007–2013 (IPADRATIC CBC, 2013) aimed to foster sustainable economic growth, further develop the attractiveness and quality of life of the maritime area and promote social cohesion and co-operation of the Adriatic region. The programme was structured into 4 priorities: (1) Economic, social and institutional co-operation; (2) Natural and cultural resources and risk prevention; (3) Accessibility and networks; and (4) Technical assistance to support the programme's management and implementation. The second priority dealt also with prevention of natural disasters and management of common risks (e.g. those affecting the coastal and marine environment), also including those related to climate extreme and change.

EU macro-regional strategies

The ADRION cooperation area coincides with the geographic scope of the EU Strategy for the Adriatic-Ionian Region[99] (EC, 2014c). The general objective of EUSAIR is to promote economic and social prosperity and growth in the region by improving its attractiveness, competitiveness and connectivity. With four EU Member States and four non-EU countries, the strategy will contribute to the further integration of the Western Balkans (EC, 2017). The EUSAIR focuses on both the land and marine resources of the region and fully incorporates the contents of the previous Maritime Strategy for the Adriatic and Ionian Seas (EC, 2012b). The strategy builds on four thematic priorities/pillars which represent key challenges as well as opportunities in the region: (1) Blue growth, (2) Connecting the Region, (3) Environmental quality, (4) Sustainable tourism. Common activities on climate change adaptation do not exist as standalone actions, and efforts for joint climate change mitigation and adaptation activities and for joint management of common resources exist – up to now – at a programmatic level. As it is underlined by the key documents of EUSAIR (EC, 2014c, 2014b), cooperation for joint management of common environmental resources as well as climate change and disaster risk management issues represent crucial challenges for the sustainable development of the Adriatic-Ionian region. Indeed, climate change mitigation and adaptation as well as disaster risk management feature as horizontal topics relevant to all four pillars of the EUSAIR strategy.

[98] Albania, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, The Former Yugoslav Republic of Macedonia, Greece, Hungary, Italy (only some of its region), Republic of Moldova, Montenegro, Romania, Serbia, Slovakia, Slovenia and Ukraine (only some of its regions).

[99] https://www.adriatic-ionian.eu/

Conventions

At the wider scale of the entire Mediterranean Sea, cooperation on environmental protection (including climate change adaptation) at transnational level is formalised in the frame of the Barcelona Convention and related protocols (for more details see Mediterranean section 3.9).

Other cooperation initiatives

In 2013–2016 the EU financed the Environment and Climate Regional Accession Network (ECRAN)[100] that assisted Balkan countries (Croatia, Serbia and Kosovo under UN Security Council Resolution 1244/99, FYROM, Bosnia and Herzegovina, Albania, Montenegro and Turkey) in exchanging information and experience in the fields of environment and climate action related to preparation for accession. Information on ECRAN in provided in section 4.2.

Adaptation strategies and plans

No adaptation strategies and plans have been developed for the moment in the specific context of the Adriatic-Ionian region. The 'Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas' (UNEP/MAP, 2016b) endorsed by the 19th meeting of Contracting Parties of the Barcelona Convention is relevant also for this specific region.

3.12 Balkan-Mediterranean

INTERREG cooperation programmes

The INTERREG V B Balkan-Mediterranean (BalkanMed) Programme[101] is a new cooperation programme, deriving from the split of the SEE Programme 2007–2013. It is focused on addressing two key challenges: territorial competitiveness and environment; and builds upon the following two priority axes, namely (1) Entrepreneurship and Innovation; and (2) Environment. Together with socioeconomic development and demography, environment, and natural and cultural heritage, climate change is recognised as one of the main challenges shared by the programme actors. Climate change adaptation is therefore relevant for the entire programme. Priority axis 2 aims to develop and implement common strategies and approaches able to foster the protection and sustainable use of natural/cultural heritage and accordingly to strengthen resources' management efficiency and climate change resilience. This axis is streamlined in two thematic objectives focusing on natural ecosystems' management and the efficient resources management of the waste, soil and water sectors.

In the programme period 2007–2013 most of the Balkan-Mediterranean countries (all but Cyprus) were involved in the South-East Europe transnational cooperation Programme (see section 3.11)

EU macro-regional strategies

There are two EU macro-regional strategies falling partially under the Balkan-Mediterranean geographical scope: EUSDR including Bulgaria and EUSAIR including Albania and Greece.

[100] http://www.ecranetwork.org/

[101] http://www.interreg-balkanmed.eu/

Conventions

At the wider scale of the entire Mediterranean Sea, transnational cooperation on environmental protection and climate change adaptation is formalised in the frame of UNEP/MAP, the Barcelona Convention and related protocols (for more details see Mediterranean section 3.9). This is relevant for some of the Balkan-Mediterranean countries (i.e. Albania, Greece and Cyprus).

Other cooperation initiatives

Initiatives described for other regions and relevant for the Balkan-Mediterranean countries include ECRAN 2014–2016[102], involving also FYROM and Albania (see the Adriatic-Ionian Region section 3.11 and section 4.2).

Adaptation strategies and plans

No adaptation strategies and plans have been developed for the moment in the region. However, the 'Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas' (UNEP/MAP, 2016b) endorsed by the 19th meeting of Contracting Parties of the Barcelona Convention is relevant for some countries of the region (Albania, Greece and Cyprus).

3.13 Overview of cooperation in transnational regions

The European transnational regions show great differences with regard to their geographic and socio-economic characteristics. In addition, the record of past collaborative experiences and the intensity of actual collaboration are quite diverse from region to region.

Table 3.1 provides a summary overview, based on the contents of the previous sections, of cooperation programmes and initiatives which have relevance for CCA and DRR in each of the 12 INTERREG transnational regions. The table confirms that the heterogeneity between regions also exists with regard to cooperation initiatives beyond the INTERREG B programmes. Some transnational regions overlap or coincide with land or sea-based international conventions (e.g. in the case of the Atlantic Area, Baltic Sea, Alpine Space, Danube and Mediterranean) and/or EU macro-regional strategies (in the case of Baltic Sea, Alpine Space, Danube and Adriatic-Ionian), which have already created a wide experience and, in some cases, established a long history of transnational cooperation. For other regions, this occurs only for specific parts as in the case of Central Europe and the Balkan-Mediterranean regions. In some areas, intense collaboration has also been developed independently from existing conventions in the form of cross border activities (as in the case of the Pyrenees or the Barents Sea) focusing on the joint management of common resources.

The existence of common climate adaptation initiatives can be traced in some of those areas which share a particular vulnerable common geographic space (e.g. Barents Sea, Pyrenees, Alps, Danube, Baltic Sea) but are only beginning work in other hot spots for climate change such as the quite complex and highly heterogeneous area of the Mediterranean.

[102] http://www.ecranetwork.org/

Table 3.1. Overview of cooperation programmes and initiatives relevant for CCA and DRR in the 12 INTERREG transnational regions
Source: ETC/CCA elaboration based on literature review

Transnational region	Role of CCA in the INTERREG B programme	EU macro-regional strategy	International conventions	Other cooperation initiatives	Specific regional strategies and plans relevant for CCA
Northern Periphery and Arctic	mainstreaming	-	OSPAR Convention (1992)	Arctic council Nordic Council of Ministers	Action Plan on Climate Change for the Barents Co-operation
Atlantic Area	priority	-	OSPAR Convention (1992)	Maritime Strategy and Action plan for the Atlantic Ocean Area (2011) Atlantic Arc Commission within the Conference of Peripheral Maritime Regions	
North West Europe	mainstreaming	-	OSPAR Convention (1992)	Vulnerability assessment for Benelux countries (2017)	
North Sea	priority	-	OSPAR Convention (1992)	North Sea Commission within the Conference of Peripheral Maritime Regions Trilateral Wadden Sea Cooperation (1978)	North Sea Region 2020 Strategy (2016) Trilateral strategy for the resilience of the Wadden Sea (2014)
Baltic Sea	mainstreaming	EUSBSR (2012) CON	Helsinki Convention (1992)	Council of the Baltic Sea States (CBSS) Union of the Baltic Cities (UBC)	Baltadapt Strategy for Adaptation to Climate Change in the Baltic Sea Region
Alpine Space	mainstreaming	EUSALP (2015)	Alpine Convention (1991)	Transnational network of national adaptation policy makers of Alpine countries (2012)	Alpine strategy for adaptation to climate change in the field of natural hazards (PLANALP, 2013) Action Plan on Climate Change in the Alps (Alpine Convention, 2009)

Transnational region	Role of CCA in the INTERREG B programme	EU macro-regional strategy	International conventions	Other cooperation initiatives	Specific regional strategies and plans relevant for CCA
Central Europe	mainstreaming	EUSDR (2010) EUSALP (2015) EUSAIR (2014)	Danube River Protection Convention (1994) Carpathian Convention (2003) Alpine Convention (1991) Helsinki Convention (1992) Barcelona Convention (1995) with its ICZM Protocol	ECRAN (2013 – 2016)	Danube Strategy on Adaptation to Climate Change (ICPDR, 2012) Danube River Basin Management Plan (DRBM Plan, 2009, 2015) Danube Flood Risk Management Plan (DFRM Plan, 2015) Strategic Agenda on Adaptation to Climate Change in the Carpathian Region (Carpathian Convention, 2014)
Danube	mainstreaming	EUSDR (2010)	Danube River Protection Convention (1994) Carpathian Convention (2003) Alpine Convention (1991) Barcelona Convention (1995) with its ICZM Protocol Bucharest Convention (1992)	International Sava River Basin Commission (ISRBC) Agreement on Cooperation and Synergy for the EUSDR Implementation between ICPDR and EUSDR (2014)	Danube Strategy on Adaptation to Climate Change (ICPDR, 2012) (ICPDR, 2012) Danube River Basin Management Plan (DRBM Plan, 2009, 2015) Danube Flood Risk Management Plan (DFRM Plan, 2015) Strategic Agenda on Adaptation to Climate Change in the Carpathian Region (2014)
Mediterranean	mainstreaming	EUSAIR (2014)	Barcelona Convention (1995) with its ICZM Protocol Alpine Convention (1991)	Union for the Mediterranean (UfM) WESTMED Maritime Initiative Bologna Charter (2014)	Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas (Barcelona Convention, 2016)
South West Europe	priority		OSPAR Convention (1992) Barcelona Convention (1995) with its ICZM Protocol	Working Community of the Pyrenees (CTP) WESTMED Maritime Initiative Atlantic Maritime strategy (2011)	Atlantic Maritime Strategy Action plan (2013) Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas (Barcelona Convention 2016)

Transnational region	Role of CCA in the INTERREG B programme	EU macro-regional strategy	International conventions	Other cooperation initiatives	Specific regional strategies and plans relevant for CCA
Adriatic-Ionian	mainstreaming	EUSAIR (2014)	Barcelona Convention (1995) with its ICZM Protocol Alpine Convention (1991) Danube River Protection Convention (1994)	ECRAN (2013 – 2016)	Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas (Barcelona Convention 2016)
Balkan-Mediterranean	mainstreaming	EUSDR (2010) EUSAIR (2014)	Barcelona Convention (1995) with its ICZM Protocol	ECRAN (2013 – 2016)	Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas (Barcelona Convention 2016)

4 Knowledge creation and sharing at transnational level

KEY MESSAGES:

- Transnational projects provide an important mechanism and have played a key role in the creation and sharing of knowledge and experiences on climate change adaptation and disaster risk reduction in transnational regions. Building a joint knowledge base, generating transferable knowledge resources and products, and exchanging and sharing knowledge are specific goals and strengths of transnational cooperation projects particularly under the INTERREG B funding schemes.
- In those transnational regions were EU macro-regional strategies and international conventions are in place, knowledge on CCA and DRR developed by transnational projects can, and is, expected to provide added value for the preparation of adaptation initiatives and actions promoted in the frame of these macro-regional strategies and/or conventions.
- Examples of projects that were not limited to creating knowledge, but that have proceeded to joint planning and (pilot) implementation of adaptation actions appear to be scarcer and are more difficult to identify.
- Projects on CCA and DRR have more often tackled specific climate change challenges or have dealt with specific sectors, while a smaller number of projects has dealt with the cross-sectoral and integrated dimension of adaptation. Foci of projects usually reflect the prevailing common features and challenges in the respective transnational regions (e.g. water resource management in the Danube region, coastal and maritime area management in regions with shared maritime areas, natural hazard management in the Alpine Space region, urban planning in densely populated regions with large metropoles, etc.).
- Transnational cooperation on CCA tends to focus on the transboundary impacts of climate change and related challenges to the management of common resources shared across borders. Border-crossing water bodies and river basins, coastal regions and shared maritime areas are thus often at the centre of transnational projects on CCA and DRR.
- Cluster projects aim to build further knowledge based on the achievements of previous single adaptation projects run in the same transnational region, as well as to improve their capitalisation and transfer that knowledge to policymakers and practitioners. Examples of these cluster projects emerged as an innovation in the previous funding period. Such cluster projects have delivered lasting impacts in the North West Europe and the Alpine region, while in the SUDOE region the so-called ‘capitalisation groups’ have pursued similar aims.
- In some cases, knowledge sharing activities are conducted through dedicated ‘transnational portals and platforms’ or by operating ‘knowledge centres’. Notable examples of transnational knowledge platforms, which fulfil similar functions for the respective (macro-) regions as Climate-ADAPT does at the pan-European level, are the CAPA Platform and the Pyrenean Climate Change Observatory.
- Structured knowledge centres, networks and initiatives are more numerous and more evenly distributed among the European regions. For example, ECRAN and regional drought

management centres have also contributed to building adaptive capacities in non-EU Member States, while the BSR Climate Dialogue Platform plays a key role in the EU Strategy for the Baltic Sea Region.

Knowledge creation and sharing at the transnational level is largely 'project-based' (see section 4.1). A significant number of projects are supported through INTERREG transnational cooperation programmes. Indeed, building a joint knowledge base, generating transferable knowledge resources and products, and exchanging and sharing knowledge feature as specific goals and strengths of transnational cooperation projects under INTERREG funding schemes. Important activities focusing on knowledge creation and sharing at transnational level are also developed within the frame of existing EU macro-regional strategies (e.g. EUSBSR or EUSALP), which rely on external funds provided by the EC, including INTERREG B, and under transnational treaties such as the Alpine, Carpathian and Barcelona Conventions. In general, efforts are made to build upon and capitalise on a joint knowledge base, concrete experiences and good practices on a variety of topics, including, directly or indirectly, adaptation. In a few cases, knowledge sharing activities are conducted through dedicated 'transnational portals and platforms' or by operating 'knowledge centres' (see section 4.2). In this paper, the focus is on knowledge sharing initiatives (platforms and knowledge centres), which can provide evidence to support to cooperation on policy and decision-making at the scale of transnational regions; accordingly, pure research-based centres and networks are not taken into consideration by this paper.

4.1 Knowledge creation through projects

This section illustrates a storyline depicting how projects have contributed creating and sharing data and knowledge on climate change adaptation for each INTERREG transnational region. The 12 storylines were created by examining five example projects[103] for each transnational region, selecting those that best represent how the transboundary knowledge on climate change impacts, vulnerability and adaptation has developed and evolved, providing evidence, when relevant, of links between the different projects and the supporting funding programmes.

Firstly, projects that address CCA and DRR that were funded in the programming periods 2007–2013 and 2014–2020 were identified for each INTERREG transnational region. DRR was included due to its obvious connection with climate change adaptation. Indeed, a number of climate-related risks (e.g. heavy precipitation, windstorms, storm surges, river and sea floods, droughts, forest fires, etc.) are expected to be exacerbated by climate change, at least in some regions of Europe; this calls for enhanced coherence of the knowledge base supporting CCA and DRR policies (EEA, 2017a). Project identification was mostly conducted through consultation of the KEEP database, which is freely accessible on-line (see Box 4.1).

[103] The number of (5) targeted projects has be considered in a flexible way. For some regions with less experience on cooperation on climate change adaptation, the number of projects can be slightly lower, while in other regions it can be slightly higher, also depending on the number of available programmes other than INTERREG ones.

Box 4.1:The KEEP database

KEEP[104] is a unique source of aggregated data and information regarding projects and beneficiaries of EU cross-border, transnational and interregional cooperation programmes among the Member States, and between Member States and neighbouring countries. Currently, the database covers the 2000–2006, 2007–2013 and 2014–2020 periods.

The idea of KEEP arose from the need for a comprehensive overview of the projects developed within the scope of EU cooperation programmes; originally, this information was stored only at programme level. The INTERACT Programme[105], with the support of the EC and the INTERREG, INTERREG IPA cross-border and ENPI/ENI cross-border programmes, built and maintains the database. INTERACT established contacts with the Joint Secretariats of the Territorial Cooperation programmes in order to extract from them as much reliable and comprehensive project data and information as possible. Uploading and updating of the information provided by the programme bodies has been ongoing since then.

The use of KEEP was integrated with the analysis of the specific web-pages of the single INTERREG programmes, which proved to be particularly useful in identifying projects funded and launched very recently. Both typologies of sources were consulted up to the middle of June 2018, which sets the temporal limit of the analysis. In the identification of CCA and DRR related projects, the following funding programmes were considered, given their focus on cooperation on operational aspects related to knowledge sharing (e.g. capitalisation of practices, development of guidelines and tools, production of data and knowledge sharing platforms, creation of long-standing networks, etc.):

- INTERREG B 2007–2013 and INTERREG B 2014–2020 programmes. These programmes are specifically dedicated to transnational cooperation in the 12 regions which form the geographic scope of this study; therefore, they also constitute the main focus in the case of the analysis of knowledge creation and sharing.
- INTERREG A 2007–2013 and INTERREG A 2014–2020 cross-border cooperation programmes. Projects funded by these programmes have been considered only in the case they have provided a significant contribution to knowledge growth on climate change adaptation and involved a significant percentage of the entire transnational region. For example, in the case of the Adriatic-Ionian transnational region, projects recently funded by the Italy–Croatia Cross-Border Cooperation 2014–2020 programme were considered because of their relevance to climate change adaptation and because this programme covers a large portion of the Adriatic sub-region.
- When relevant (i.e. in the case of the Mediterranean Sea) ENPI 2007–2013 and ENI 2014–2020 programmes have also been considered to show examples of knowledge transfer, capitalisation and co-creation involving non-EU-countries belonging to the transnational region.

[104] https://www.keep.eu/keep/

[105] http://www.interact-eu.net/

INTERREG C, Life and seventh Framework (FP7) and H2020 programme funded projects have not been considered in this analysis, despite being important sources of EU finance for the development of CCA and DRR related knowledge (EC, 2013c). Although they surely imply cooperation among partners of different countries, it can be argued that they do not directly focus on the specific challenges shared within the transnational regions, so are potentially less effective in providing a region-specific cooperation framework for the implementation of joint actions and policy exchanges between national, regional and local actors from different Member States, which is the essential scope of the INTERREG B programme.

Finally, examples of projects funded by other (non-EU) mechanisms have been considered for some transnational regions, referring in particular to those projects that played a significant role in knowledge creation through transboundary cooperation. For instance, the case of the Mediterranean region is an example of a Global Environment Facility (GEF) funded project is reported, or of the Alpine Space, showing a fertile substrate of other funding initiatives of climate change related projects.

In conclusion, based on the scanning effort described above, about five examples of most representative projects were selected for each INTERREG transnational region and used to derive the project-based storylines. Two main criteria were applied to select these projects:

1. Transnational dimension of the projects and therefore their relevance in terms of cooperation between countries that are part of the same transnational region. The selection of projects tended to consider those involving partners that represent the larger number of countries, thus being representative of a wide portion of the transnational region.
2. Clear reference to climate change, and specifically climate change adaptation. Given its link to the latter, DRR was also considered as part of this second criterion. The selection phase focused on those projects that have produced an obvious advancement in knowledge creation on CCA and DRR including tools, guidelines, shared/capitalised practices, case studies, pilots on implementation of adaptation measures, advanced stakeholder engagement, etc. Projects that generated tangible outcomes that are still in use (e.g. knowledge sharing platforms, climate change strategies or plans, knowledge sharing centres, etc.) have been considered as particularly relevant.

The resulting storylines are quite heterogeneous. They undoubtedly reflect the different traditions and experiences of cooperation on climate change adaptation but are also influenced by the history of the INTERREG funding programmes characterising each transnational region, with some of them being very new (e.g. the Balkan-Mediterranean Programme). In some cases, project examples demonstrate the cross-cutting/cross-sector nature of CCA well, while in other cases they focus on specific aspects (e.g. climate change impacts, vulnerable areas, or vulnerable sectors, etc.) that are particularly relevant for the transnational region.

4.1.1 Northern Periphery and Arctic

The 2007–2013 Northern Periphery Programme included projects on local communities (Clim-ATIC) and coastal adaptation (CoastAdapt). The **Clim-ATIC** (Climate Change – Adapting to The Impacts, by Communities in Northern Peripheral Regions)[106] project (2009–2011) focused on adaptation at community-level with case studies in Finland, Sweden, Norway, Scotland and Greenland. The main themes and sectors addressed by the project were transport, energy, extreme weather events and tourism. For example, in the tourism sub-project, the relevance of adaptation in regional and national tourism strategies for Lapland and Finland was assessed and compared with views of entrepreneurs in the sector obtained through questionnaires and in stakeholder workshops (Kietäväinen et al., 2011). Tourism services that can be provided throughout the year were developed as one adaptation measure to reduce the dependency on snow-based winter tourism, which is affected by shorter snow seasons.

The **CoastAdapt** (The Sea as Our Neighbour: Sustainable Adaptation to Climate Change in Coastal Communities and Habitats on Europe's Northern Periphery) project[107] (2009–2012) aimed to safeguard people living in North Atlantic coastal communities and help them adapt to the impacts of climate change. A series of community workshops was organised in five coastal pilot study sites in Iceland, Norway, Ireland and Scotland. CoastAdapt developed a bottom-up approach to building local capacity for climate adaptation, involving awareness raising and assessment of vulnerabilities, identification and assessment of adaptation options and actions in relation to available resources, and finally guidance on how to incorporate or mainstream adaptation actions into policies and operations (Muir et al., 2014; Gray et al., 2014).

Some projects with a strong focus on climate change adaptation are also financed in the ongoing INTERREG V B Northern Periphery and Arctic Programme 2014–2020 dealing with the specific aspects of water management and cultural heritage, as many heritage sites in the region are located in close vicinity to sea or river waters. Water bodies are not limited by national borders and hence their management strongly benefits from regional cooperation. One project (CLIMATE; see below) focuses on the development of adaptation plans at the local level.

The **Water-Pro** (Northern Runoffs into Profits)[108] project (2016–2019) aims to develop and transfer eco-efficient tools and models for runoff management in the field of agriculture and mineral extraction in Northern and Arctic areas. Runoffs from both of these sectors have large volumes, but low concentrations of nutrients and other compounds; therefore, some similar measures and practices could be utilised. More frequent and intense rainfall, as projected under climate change, will bring further challenges in controlling runoffs and water safety in the near future. The project is developing a toolbox of good management practices and a communication platform for the agricultural and mining extraction industries. In addition, several innovative, low-cost practices will be implemented at the actual pilot sites, and their treatment and cost-efficiency evaluated. Water-Pro will also enhance the preparedness of responsible authorities and local resource users to protect water quality, human health, ecosystems and stimulate economic growth and development.

[106] http://www.northernperiphery.eu/en/projects/show/&tid=15

[107] http://www.northernperiphery.eu/en/projects/show/&tid=61

[108] http://www.water-pro.eu

The **ANH** (Adapt Northern Heritage)[109] project (2017–2020) supports communities and local authorities to adapt northern cultural heritage to the environmental impacts of climate change and associated natural hazards through community engagement and informed conservation planning. The project will develop an on-line tool to assess the risks and vulnerabilities of historic places, e.g. the impacts of flood events, coastal and riverbank erosion, rising sea levels, severe storms and permafrost thawing. It will provide guidance for the planning of strategic adaption measures that take into account cultural, economic, environmental and social sustainability. The tool will be developed, tested and demonstrated in nine case studies, in Iceland, Ireland, Norway, Russia, Sweden and Scotland, for which adaptation actions plans will be produced. The project will also create a community network with a networking platform, round table workshops and training events.

The **CLIMATE** (Collaborative Learning Initiative Managing and Adapting to the Environment)[110] project (2017–2020) aims to promote and improve climate change awareness in European peripheral rural communities through a knowledge-based approach and community led sustainable resource planning. It brings together local authorities in remote, sparsely populated areas from Sweden, Northern Ireland, Republic of Ireland and the Faroe Islands with the aim of developing adaptation plans. The project plans to develop a risk assessment and preparedness scale, and a portal and knowledge hub that ensure transferability of project outcomes to other local authorities in the region.

4.1.2 Atlantic Area

Given the maritime character of the Atlantic transnational region, addressing specific coastal risks and impacts from climate change is one of the key challenges in the area, further to addressing specific impacts of climate change on inland economic activities, especially agriculture and forestry.

Coastal risk management had an important role during the 2007–2013 programming period, with the ANCORIM (Atlantic Network for Coastal Risks Management)[111] project (2009–2012), which developed best practice guidance for coastal risk assessments and mitigation of climate risk in coastal areas, including guidance for the consideration of coastal risks in public planning. The guidance material produced also includes an overview on soft solutions for coastal protection and several guidance documents for decision-making, for the customisation of guidance to specific local conditions and for awareness-raising by addressing school children. The 15 project partners came from Portugal, Spain, France and Ireland. It had no direct follow-up among the projects in the subsequent programming period of the Atlantic area programme. However, the lead partner of the **ANCORIM** project, the Atlantic regional office of the Coastal & Marine Union (EUCC), used ERDF funding from the regional programme Aquitaine 2014–2020 to finance the **CORIMAT** (Coastal Risks Management Atlantic Stakeholders Network)[112] project, which aims to revitalise the ANCORIM network, extending the stakeholder platform and providing public access to the resources elaborated within ANCORIM project (educational tools, case studies, guidelines).

[109] http://adaptnorthernheritage.interreg-npa.eu

[110] http://climate.interreg-npa.eu

[111] https://www.keep.eu/keep/project-ext/670/Atlantic Network for Coastal Risk Management

[112] https://corimat.net

Within projects approved so far in the programming period 2014–2020, the focus has been on mainstreaming the consideration of CCA and DRR coastal and maritime challenges into economic development of key sectors in the area, for instance, aquaculture and fisheries. As an example, the PRIMROSE (Predicting Risk and Impact of Harmful Events on the Aquaculture Sector) project[113], started at the end of 2017 and runs up to 2020. Led by the Irish Marine Institute, the project will provide knowledge for the management of risks related (inter alia) to climate hazards on the aquaculture sector, generating a system for transnational short- to medium-term risk forecasting and a long-term assessment of climate impacts on harmful algal blooms and pathogens. This improved forecast will include assessments of microbial risk and climate impacts, in addition to algal bloom predictions. The 10 project partners include academic research organisations in all five countries participating in the programme, and representatives of the fisheries and aquaculture sector in UK and Spain. Although adaptation is not addressed explicitly, climate change is one of the pressures on marine ecosystems which was considered in terms of challenge posed by invasive species[114]. The MyCOAST project[115] (2017–2021) aims to provide climate services for economic activities along the coast of the Atlantic area and information for early warning systems related to coastal flooding. It also aims to create a climate change coastal observatory (see section 4.2).

On the terrestrial side, **REINFFORCE** (REsource INFrastructure for monitoring and adapting European Atlantic FORrests under Changing climatE)[116] (2009–2013) financed under the Atlantic area 2007–2013 programme created a network of test sites across the whole programme area, including the Azores islands, to monitor climate change and to test the efficiency of adaptation measures for the long-term protection of Atlantic forests. The project partnership consisted of 11 research institutes and public authorities from Spain, Portugal, France and the United Kingdom. It created a network of arboreta to assess the adaptability of different tree varieties to a wide range of climatic and environmental conditions and as a network of demonstration sites for monitoring the efficiency of adaptive silviculture.

Among the projects approved in the current programming period, the **Risk-AquaSoil** (Atlantic risk management plan in water and soil) project[117] (2017–2019) aims to define a comprehensive management plan for climate risks related to soil and water to improve the resilience of the Atlantic rural areas. The management plan encompasses the design of early warning and diagnostic services, and the development and testing of innovative strategies for better soil and water management taking into account the risks associated with climate change. Stakeholder and local communities will be involved in training for capacity building activities and in risk management and damage compensation systems.

4.1.3 North West Europe

During the 2007–2013 period, the North West Europe Programme financed several projects which generate specific knowledge for different climate adaptation and climate proofing challenges. Climate impacts and adaptation needs addressed by these projects focused on water management, related to

[113] http://www.pml.ac.uk/Research/Projects/PRIMROSE_Predicting_Risk_and_Impact_of_Harmful_Ev

[114] In a similar way also the LIFE+ funded project "Celtic Seas Partnership" (www.celticseaspartnership.eu; 2013–2017), aimed at designing and testing innovative and cooperative forms of transnational management of marine areas for the specific Celtic Sea area.

[115] http://www.pml.ac.uk/Research/Projects/MyCOAST

[116] http://www.iefc.net/newsite/sitereinfforce/

[117] http://www.atlanticarea.eu/project/3

both inland water resources and coastal adaptation needs and, with some overlaps, on urban adaptation to climate change where adaptation to urban flood risk again represented a core issue.

Projects focusing on water management included **AMICE**[118] (Adaptation of the Meuse to the Impacts of Climate Evolutions) (2009–2012) which explores floods and low-flows with the perspective of sustainable development in the Meuse international catchment basin. The 17 project partners from Germany, the Netherlands, Belgium and France collaborated in climate proofing the Meuse river catchment, identifying physical and management options in response to the climate change impacts expected for the river basin, including management of low flow regimes as well as flood events. The participation of river basin management authorities alongside scientists and river users allowed for the development of a basin-wide adaptation strategy based on agreed common principles and collaborative mechanisms, that can be potentially transferred into other international river basins. The expected greater variation of water regimes were addressed also by the **DROP** (benefit of governance in DROught AdaPtation)[119] project (2012–2015), in which partners and stakeholders from UK, France, Belgium, the Netherlands and Germany investigated the trade-offs between flood protection and drought risk measures, and experimental adaptation measures involving relevant stakeholders in site visits and planning for adaptation measures.

Among the projects focusing on urban adaptation needs, **Future Cities** (Urban Networks to Face Climate Change) project (2007–2013)[120] involved partners from cities in Germany, the Netherlands, Belgium and the UK. These partners developed concepts and implemented guidance tools for adaptation in cities, supporting the development and implementation of small-scale, innovative, proactive, cost effective and synergic measures as part of local action plans in the partner cities: Kamen and Bottrop (Germany), Nijmegen and Tiel, (the Netherlands), Ieper (Belgium) and Hastings (UK). The pilot implementations provided examples of retro-fitting existing urban infrastructure combined with green infrastructure.

While interaction between partners in the cities network focused mainly on common development of suitable strategies in each of the urban areas, in the **IMCORE** (Innovative Management for Europe's Changing Coastal Resource) project (2007–2012)[121] project partners interacted to create the basis for a common, transnational governance of coastal resources. Activities focused on strategies for adaptation to climate-induced changes in shorelines, addressing the selection of appropriate adaptation measures and governance options for coastal use and management. The project developed a methodology and templates to aid coastal managers across North West Europe in developing the required adaptive strategies, reducing ecological, social and economic impacts of climate change on coastal resources.

The eight climate adaptation projects[122] (from seven Member States and with around 100 partner organisations) funded in the 2007–2013 INTERREG programming period were grouped in **SIC-adapt!**

[118] http://www.amice-project.eu/en

[119] http://www.nweurope.eu/about-the-programme/our-impact/challenge-5/the-drop-project/

[120] https://www.keep.eu/keep/project-ext/21124/Future+Cities?ss=5ba05f983f764dbc861db631bf15498b&espon

[121] http://www.imcore.eu

[122] The INTERREG IV B projects participating in the cluster were Future Cities (Urban Networks to Face Climate Change), ALFA (Adaptive Land Use for Flood Alleviation), AMICE, C-Change (Changing Climate.Changing Life), FloodResilienCity (FRC), ForeStClim (Transnational Forestry Management Strategies in Response to Regional Climate Change Impacts), IMCORE and WAVE (Water Adaptation is Valuable for Everybody)

(Strategic Initiatives Cluster – Adaptation to the spatial impact of climate change) (2010–2013)[123], a strategic cluster of the INTERREG IV B North West Europe Programme. The cluster aims to increase visibility of project outcomes in terms of adaptation tools and measures, and produced policy recommendations at EU, national and regional levels on the basis of joint findings of the cluster projects. Among the policy recommendations, a document addressed the new INTERREG programme period, in particular suggesting it should:

- Trigger and strengthen the coordination between sectors including the water sector and spatial regional planning as well as urban planning.
- Contribute to the improvement of the coordination of EU directives with practical ideal solutions, especially the water framework directive, floods directive and – if it is decided – a future climate change adaptation directive.
- Improve international cooperation in water management and in risk management in international river basins.
- Support projects on agricultural practice and climate change (SicAdapt, 2013).

These appeals for prioritising adaptation challenges have only been partly reflected in the following programming plan for the North West Europe transnational region (2014–2020), which eventually chose to mainstream CCA and DRR objectives with mitigation goals, and not to establish a stand-alone priority on adaptation. Climate change is addressed by the programming plan with a priority for climate change mitigation, which can also include adaptation activities under the form of "*mitigation relevant adaptation solutions*… [" (INTERREG NWE, 2015, p. 11). On the other hand, the programming document clearly indicates need for additional knowledge in tackling climate change risks, especially in urban areas. As of June 2018, none of the approved projects seems to directly address adaptation-related challenges.

4.1.4 North Sea

Several projects in the 2007–2013 INTERREG North Sea Programme dealt with adaptation, with a focus on flood risk or a more cross-cutting approach on issues related to water management. For example, the **SAWA** (Strategic Alliance for integrated Water Management Actions) project[124] (2008–2011) improved the consideration of the climate change aspects of flood risk management plans for five pilot catchments in Germany, Sweden and Norway. The **CPA** (Climate Proof Areas) project[125] (2008–2011) dealt with a wider range of water management factors in coastal and inland waters of the region and as a result was more cross-cutting.

In the current funding period 2014–2020, the INTERREG V B North Sea Programme has a similar number of projects with a clear focus on climate change adaptation. These mostly focus on coastal and river flood protection and on water-related issues in sub-surface or urban environments, for example, caused by drought, heavy rainfall or flood events. Nature-based solutions (NBS) for flood protection are being

[123] https://www.keep.eu/keep/project-ext/21125/SIC+adapt%21?ss=5ba05f983f764dbc861db631bf15498b&espon

[124] http://archive.northsearegion.eu/ivb/projects/details/&tid=86

[125] http://www.climateproofareas.com

developed in several projects, such as in **BwN** (Building with Nature)[126] (2015–2020). This project aims to make coasts, estuaries and catchments in the North Sea region more adaptable and resilient to the effects of climate change by using NBS. The latter are being implemented at seven coastal sites (for example sand nourishment at North Sea Coasts and Wadden Sea barrier islands) and six catchment sites (dealing with, for example, river restoration). The BwN project uses these living laboratories as examples for creating an evidence-base for selecting sites, designing measures and calculating the costs, benefits and effectiveness of measures with a view to ultimately generating business cases.

The **FAIR** (Flood infrastructure Asset management and Investment in Renovation, adaptation and maintenance) project[127] (2015–2020) also deals with coastal flood and aims to reduce flood risk across the North Sea region by demonstrating adaptation solutions to improve the performance of flood protection infrastructure. FAIR demonstrates improved approaches for cost-effective upgrading and maintenance, optimising investments across national-system-asset levels, as well as applying adaptive, innovative technical designs. The project develops adaptation solutions for dykes, sluices, dams, and flood gates at target sites in Belgium, Germany, Denmark, Sweden, Norway and The Netherlands.

FRAMES (Flood Resilient Areas by Multi-layEred Safety)[128] (2016–2020) is a project that aims to increase the resilience of areas and communities by working with the Multi-Layer Safety (MLS) concept. Different 'layers' of resilience (prevention, spatial adaptation, emergency response and recovery) are integrated, leading to: (1) flood resilient areas (improved infrastructure and spatial planning measures), (2) flood resilient communities (better prepared inhabitants and social stakeholders) and (3) flood resilient authorities (reduced recovery times and increased response capacity). The project works on 13 pilots in areas which are comparable from a geographic and demographic point-of-view, thus allowing for coherent monitoring to generate new insights and solutions.

The **TOPSOIL** (Top soil and water – The climate challenge in the near subsurface)[129] is a 2015–2020 project that explores the possibilities of using topsoil layers to solve current and future water challenges in the North Sea region. The project looks beneath the surface at the groundwater and soil conditions, predicts and finds solutions for climate-related threats, such as flooding during wet periods and drought during warmer seasons. The overall objective is the joint development of methods to describe and manage the uppermost 30 m of the subsurface as a way to improve its climate resilience. The project will demonstrate a practical implementation of solutions in 16 case studies.

Finally, the overall objective of **CATCH** (Water sensitive Cities: the Answer To CHallenges of extreme weather events) project[130] (2016–2020) is to demonstrate and accelerate the redesign of urban water management of midsize cities in the North Sea region in order to become climate resilient urban areas that are sustainable, liveable and thriving in the long-term. This will be achieved through the joint development of decision-support tools that will support formulation of long-term climate adaptation strategies. The design of the tools is based on the specific needs and characteristics of midsize cities. The tools will be tested in the formulation, execution and evaluation of 7 pilots. These include NBS to

[126] http://www.northsearegion.eu/building-with-nature

[127] http://www.northsearegion.eu/fair

[128] http://northsearegion.eu/frames

[129] http://www.northsearegion.eu/topsoil

[130] http://northsearegion.eu/catch

improve water storage capacity during heavy rainfall events and a traffic management system to re-route traffic in times of flooding.

4.1.5 Baltic Sea

The INTERREG Baltic Sea Programme 2007–2013 funded three projects dealing with climate change adaptation or DRR and thus contributing to the EUSBSR strategy (see section 3.5).

The **BaltCICA** (Climate Change: impacts, costs and adaptation in the Baltic Sea Region)[131] project, running from 2009 to 2012, developed adaptation measures with relevant planning authorities and stakeholders, and assessed costs and benefits in case studies and at a pan-Baltic level. BaltCICA aimed to achieve better capability to deal with the impacts of climate change at those levels where concrete adaptation measures have to be implemented and are experienced directly by the population. The project focused on assessing the impacts of climate change on water bodies and drinking water supply, as well as adapting to sea level rise and changing frequency and magnitude of floods for the cities and regions located along the Baltic coast. Adaptation measures were developed in cooperation with local authorities and administrative bodies, and were discussed with other stakeholders. The project developed 13 case studies focusing on different thematic areas: metropolitan planning and adaptation strategies (Hamburg in Germany, Tampere in Finland, Helsinki and its Metropolitan Region in Finland), groundwater and climate change (Hanko in Finland, Klaipeda in Lithuania and Falster in Denmark), the environment (North Vizdeme in Latvia and Karklė in Lithuania) and scenario development and citizen participation (Kalundborg in Denmark, Riga in Latvia, Klaipeda, Tampere and Hamburg). Successful methods for the development and implementation of adaptation measures were transferred from case studies to other contexts in the region facing similar problems.

The **Baltadapt project**[132] (2010–2013) brought together leading expert institutions from Denmark, Germany, Latvia, Lithuania, Estonia, Finland and Sweden to create a knowledge brokerage process in the field of climate change adaptation. The project developed an adaptation strategy for the Baltic Sea Region as well as an action plan (Altvater and Stuke, 2013; Andersson, 2013) (see also section 3.5). The strategy was developed through a consultation process between relevant policymakers and stakeholders during three policy fora. The action plan provides guidance on how to strengthen adaptive capacity in the Baltic region through knowledge exchange, mainstreaming and cooperation activities, and identifies adaptation actions for the four main areas of marine biodiversity, coastal infrastructure, tourism and food supply. The Baltadapt strategy for Adaptation to Climate Change in the Baltic Sea Region has been endorsed at a policy level through its integration into the EUSBSR strategy. The project also published a series of 12 assessment reports that identify and reflect the knowledge base with regards to climate change adaptation in the Baltic Sea Region.

The **BalticClimate** (Baltic Challenges and Chances for local and regional development generated by Climate Change)[133] project (2008–2012) targeted small- and medium-sized cities and rural areas in the Baltic Sea region to identify climate change-related opportunities, and improve inclusion of climate change information in their long-term strategies and planning. The project developed the 'BalticClimate

[131] http://www.baltcica.org

[132] http://www.baltadapt.eu

[133] http://www.balticclimate.org

TOOLKIT'[134] that supports policymakers, spatial planners and business people in making adaptation decisions. It gives step-by-step guidance for conducting vulnerability assessments, developing adaptation strategies and implementing adaptation, with examples from seven project target areas in the region. For businesses, the project developed a dedicated 'Climate-Strengths-Weaknesses-Opportunities-Threats (SWOT) tool' to represent product-related climate information relevant both for mitigation and adaptation (Pesonen and Horn, 2014).

As of June 2018, none of the projects approved by the INTERREG V B Baltic Sea Programme 2014–2020 seems to directly address adaptation-related challenges. However, the INTERREG V A Central Baltic Cross-Border Cooperation Programme 2014–2020, which includes a significant portion of Central Baltic in its cooperation area (consisting of parts of Finland, Sweden, Estonia and Latvia), has funded the EUSBSR flagship project[135] **iWater** (Integrated Storm Water Management)[136] which ran from 2015 to 2018. While previous projects implemented in the framework of the INTERREG Baltic Sea Programme 2007–2013 had a cross-sectoral approach to climate change adaptation, iWater had a sectoral emphasis on water management. In particular, it aimed to improve urban planning practices in the cities of the Baltic Sea Region through the development of an integrated storm water management system. The project partner cities and municipalities (Riga and Jelgava in Latvia, Söderhamn and Gävle in Sweden, Tartu in Estonia, Helsinki and Turku in Finland) adopted new programmes and tools that were eventually integrated into urban planning processes. Using these pilot sites as examples, transferable guidelines and tools were developed in the partner cities with the involvement of local stakeholder and interest groups. Approximately 35 other Baltic Sea cities in the region were trained to use the methods developed.

4.1.6 Alpine Space

Alpine Space projects and their achievements have played a significant role in building a transnational knowledge base for adaptation, in promoting agenda-setting, inception and exploration of adaptation policies as well as in piloting climate adaptation initiatives in many Alpine countries and regions. There is some evidence that transnational cooperation has played a door-opening role in some countries and contributed to putting adaptation on national and regional policy agendas (Menzel and Pütz, 2013; Lexer et al., 2013). Alpine Space projects regularly generate major added value through efforts to transfer, replicate and capitalise on adaptation knowledge, including implementation experiences and good practices, in other countries of the cooperation area.

A critical mass of projects on climate impact and adaptation issues funded by the INTERREG ASP Programme in previous funding periods has contributed to building adaptation capacities in the Alpine countries. In retrospect, these projects form a sequence, traversing distinct stages of the policy cycle, from (1) strategic policy development to (2) exploration and piloting, and (3) to capitalisation and policy implementation. In the following, a few selected projects per phase exemplify typical outcomes and illustrate a bandwidth of impact-achieving mechanisms of transnational knowledge creation and sharing. In the present funding period, due to the design of the current ASP objectives, after three calls only one

[134] http://www.toolkit.balticclimate.org

[135] *Flagship projects* are means to implement the actions in the priority areas of the EUSBSR Strategy and serve as pilot examples. These projects have important macro-regional impact and start from joint initiatives involving partnership from different Baltic Sea region countries.

[136] https://www.integratedstormwater.eu

approved project is dedicated to climate adaptation as a stand-alone topic, while a limited number of further projects appear to consider co-benefits for adaptation in rather indirect or implicit ways.

In the period 2007–2013, the ASP funded a series of projects focusing on a broad range of climate change impacts and adaptation options[137]. Eight of these projects approved in the first half of the programme cycle had a strong sector-related focus, dealing with sector-specific climate impacts and response measures, encompassing spatial planning, natural hazards prevention, forestry, tourism, water and lake management, transport infrastructure, and permafrost monitoring.

Evolving out of a thematic work package of the **ClimChAlp** (Climate Change, Impacts and Adaptation Strategies in the Alpine Space)[138] project (2006–2008), the **CLISP** (Climate Change Adaptation by Spatial Planning in the Alpine Space)[139] project (2008–2011) responded to increasing climate impacts on settlements, infrastructure and land use activities by aiming to develop climate-proof spatial planning approaches. Based on Alpine-wide climate scenarios and a comprehensive vulnerability assessment of sectors relevant to spatial development, CLISP has provided, among others, the following key outputs to support spatial planners in integrating climate change and adaptation: multi-step guidance (including assessment criteria and checklist) for planners to assess the climate change fitness of spatial planning, a transferable toolbox and guidelines for spatial vulnerability assessment, and enhancement options for climate-proofing spatial planning instruments and procedures. The project also proposed an Alpine Strategy for Climate Proof Spatial planning, assigning spatial planning a key role in future sustainable development to face the adversities brought about by climate change. The example of CLISP demonstrates that transnational project results can play an enabling role for policy uptake in the participating countries (Truong and Menzel, 2012). Traceable impacts on national policy making, presumably facilitated by the direct involvement of responsible authorities in a partner role, include incorporation of spatial planning as a distinct action field in the Austrian National Adaptation Plan (BMLFUW, 2012, 2017), mainstreaming of adaptation in the Austrian Spatial Development Concept (ÖROK, 2011), setup of a sectoral adaptation strategy for spatial development at a federal level with concrete follow-up projects in Switzerland, as well as approaches to translate project results in administrative planning guidance in some territories.

Responding to changes in frequency, intensity and extent of natural hazards, the parallel **AdaptAlp** (Adaptation to Climate Change in the Alpine Space)[140] project (2008–2011) analysed climate change impacts on the water regime and natural hazard processes, created a dataset on climate-induced trends, and generated products and recommendations for natural hazard management and disaster risk reduction. High-profile outputs include an Information Technology (IT)-based tool for risk dialogue, technical handbooks for hazard mapping and for tracing past torrential process events, an Alpine-wide youth information campaign to foster risk preparedness, and strategic recommendations for meeting the risks of climate change and natural hazards in the Alps. Results have been taken up and further developed in other transnational cooperation contexts, including the PLANALP platform[141], the thematic

[137] http://www.alpine-space.org/2007–2013/projects/projects-per-thematic-field/index.html

[138] ClimChAlp was funded by the INTERREG III B Alpine Space Programme. The project was successful in putting for the first time the novel topic of adaptation on the transnational policy agenda of the Alpine region and revealed the need for further, more targeted efforts; http://www.alpine-space.org/2000–2006/climchalp.html

[139] http://www.alpine-space.org/2007–2013/projects/projects/detail/CLISP/show/index.html

[140] http://www.alpine-space.org/2007–2013/projects/projects/detail/AdaptAlp/show/index.html

[141] http://www.alpconv.org/en/organization/groups/WGHazards/default.html

working body for natural hazard management of the Alpine Convention, and EUSALP AG8[142] (Action Group on Risk Governance).

Against the background of projected decreases in summer precipitation, **AlpWaterScarce** (Water Management Strategies against Water Scarcity in the Alps)[143] (2008–2011) tackled the rising risks of water scarcity and exacerbated conflicts over water use in drought-prone Alpine regions. The project provided tools to mitigate water scarcity risks and developed decision-support instruments for the long-term management of water resources. Main results include a climatic scenarios guideline for monitoring and modelling mountain water resources, strategies and recommendations for water managers and policy-makers, and prototypes of early warning systems for water scarcity in four pilot regions. The latter has been advanced in the subsequent C3-Alps project and incorporated in administrative practices in Italian regions.

Being representative of the intervention logic of most Alpine Space projects, all three above mentioned projects carried out concrete pilot, testing, demonstration and implementation activities in up to 23 pilot areas per project, all across the Alpine arc. These regional pilot activities are regularly reported to have achieved the greatest impacts in terms of awareness-raising, agenda-setting and initiating concrete action on adaptation, including spill-over effects into other regions (ERDF, 2014).

Initiated by the CLISP lead partner, a cluster of all adaptation projects running in parallel in the funding period 2007–2013 was organised in a bottom-up approach to facilitate cross-project exchange and utilisation of synergies. Building on the cluster initiative, the capitalisation project **C3-Alps** (Capitalising Climate Change Knowledge for Adaptation in the Alpine Space)[144] (2012–2014) was developed and was running at the end of the same funding period. C3-Alps aimed to synthesise, transfer, evaluate and put to practical use the knowledge and outputs generated by the preceding individual projects. In order to bridge the gap between adaptation knowledge and decision-making, the project design was embedded in a target group-oriented knowledge transfer and communication concept. C3-Alps has delivered durable key achievements, such as **CAPA**, which is now maintained and further deployed on behalf of EUSALP Action Group 8[145] (see section 4.2), the establishment of a permanent transnational network of the national adaptation policymakers in the Alpine countries (see section 3.6), and the national adaptation strategy of Liechtenstein[146]. Moreover, C3-Alps successfully conducted pilot implementation activities in 12 model regions across the Alps. A typical example of the results produced by the pilot activities is the Climate Adaptation Fitness Check Tool for municipalities, accompanied by a manual on how to transfer the tool to other countries, which has been distributed to all Bavarian municipalities and has triggered concrete follow-up activities there.

In the current INTERREG V B Alpine Space Programme 2014–2020, a relatively limited number of current projects address solutions to environmental problems that may be seen as being coherent with overall adaptation goals, and thus as contributing to adaptation in an indirect and implicit way. At June 2018 the only project dealing with adaptation as a stand-alone topic is **GoApply** (Multidimensional governance of

[142] https://www.alpine-region.eu/action-group-8

[143] http://www.alpine-space.org/2007–2013/projects/projects/detail/Alp-Water-%20Scarce/show/index.html

[144] http://www.alpine-space.org/2007–2013/projects/projects/detail/C3-Alps/show/index.html

[145] http://www.capa-eusalp.eu

[146] https://www.llv.li/files/au/anpassungstrategieklimawandel-li.pdf

climate adaptation in policy-making and practice) (2016–2019)[147]. The project idea and the partnership evolved directly from the transnational policymaker network initiated by C3-Alps. Tackling adaptation barriers in the Alpine countries related to multilevel governance challenges, GoApply aims to improve the vertical implementation of national adaptation policies across levels, supporting the horizontal integration of adaptation into sectors and strengthening governance capacities of public and non-public actors by developing governance enhancement options and innovations. The objectives mirror the progress achieved in national adaptation policymaking: national adaptation strategies and/or action plans are by now in place in all Alpine countries (with their development often having benefitted from previous transnational projects), but all strategy coordinators are struggling with governance-related barriers to their implementation in practice.

Apart from the INTERREG Alpine Space Programme, the Alpine Convention and bodies of EUSALP are also contributing to transnational knowledge creation and transfer on adaptation. Prominent examples of work results of the Alpine Convention include the 'Alpine strategy for adaptation to climate change in the field of natural hazards' (2013)[148], 'Guidelines for climate change adaptation at the local level in the Alps' (2014)[149], and a 'Synthesis report – Stock-taking as basis for defining activities of the Alpine Climate Board' (2017)[150]. The forthcoming 7th Report on the State of the Alps is dedicated to natural hazard risk governance. Moreover, the umbrella NGO CIPRA International[151] carried out the **cc-alps** (climate change: looking one step further) project[152] from 2008–2012, leading to a database of good practice examples and a series of sectoral documents ('compacts') with recommended climate action, including adaptation measures.

4.1.7 Central Europe

Transnational projects funded by the INTERREG Central Europe Programme 2007–2013 have generated a wide variety of products and achievements, frequently including handbooks, guidance documents, pilot actions, awareness-raising activities, and training, and developed policy documents, strategies and recommendations for policy improvement. An analysis conducted by Kelemen et al. (2014) on behalf of the programme shows that climate change and environmental risks are issues for which transnational cooperation between regions has a special relevance. Apart from several projects dealing with challenges at least indirectly related to climate change, such as water management and flood protection, three projects have explicitly addressed the topic of risk prevention and climate change adaptation. In particular, they tackled the need for methodological and technical solutions with regard to extreme weather events, heat island phenomena, and climate change-related threats to habitats. After two calls for projects (at June 2018) in the current funding period 2014–2020, 8 out of 33 approved projects running under priority 3 on 'Environment and culture' appear to have at least an indirect relationship with climate adaptation, including adaptation to current climate variability[153].

[147] http://www.alpine-space.eu/projects/goapply/en/home

[148] http://www.alpconv.org/it/organization/groups/WGHazards/Documents/PLANALP_Alpine_strategy.pdf

[149] http://www.alpconv.org/en/publications/alpine/Documents/guidelines_for_climate_change_EN.pdf

[150] http://www.alpconv.org/en/organization/groups/alpineclimateboard/Documents/ACB_stock taking_synthesis.pdf

[151] http://www.cipra.org/en/cipra/international?set_language=en

[152] http://www.cipra.org/en/cipra/international/projects/completed/cc-alps

[153] http://www.interreg-central.eu/Content.Node/projects/home.htmlà#

The **INCA-CE** (Integrated nowcasting system for the Central European area) project (2010–2013)[154] aimed to reduce adverse effects of weather-related natural disasters (e.g. windstorms, flooding, mudflows, ice, drought) by establishing a state-of-the-art, high-resolution, real-time analysis and forecast system on atmospheric, hydrological and surface conditions. These meteorological forecasts are then joined with practical applications designed to manage road safety, civil protection and hydrology in various locations of central Europe. This enables public authorities to use meteorological information to better prepare for hazardous weather events, thereby reducing risks to the general public. Systems set up by the project are continuing to operate beyond the project lifetime[155]. The project has achieved a lasting impact through the establishment of a network with other projects, and collaboration in related fields of research and application. The World Meteorological Organization (WMO) selected INCA-CE as a 'World Weather Research programme/Forecast Demonstration project'. The INCA model is currently being used or investigated by 24 European partners (Kelemen et al., 2014).

Building on cooperation between meteorologists and urban planners, the **UHI** (Development and application of mitigation and adaptation strategies and measures for counteracting the global Urban Heat Islands phenomenon) project (2011–2014)[156:] developed policies and practical actions to reduce the impact of the urban heat island (UHI) phenomenon. The UHI project has developed a 'gold standard' for assessment and monitoring of UHI, enabling cities that have not yet set up monitoring or have insufficient monitoring capacity to identify critical areas and develop optimal strategies for adapting to UHI impacts. Further key outputs with high transfer potential include forecast modelling methodologies, a manual for UHI assessment, and adaptation options to mitigate UHI effects. Pilot initiatives in 8 metropolitan areas involved feasibility studies, strategies for governance and planning interventions, and plans for counteracting urban heat island effects, which can be integrated into national and regional programmes for urban and land use planning. The UHI project has contributed to capacity building and knowledge exchange in participating cities with differing levels of experience, and is contributing to transnational exchange of knowledge and information in order to increase adaptive capacity in the Central Europe region (Kelemen et al., 2014).

The main aims of the **HABITAT-CHANGE** (Adaptive management of climate-induced changes of habitat diversity in protected areas) project (2010–2013)[157] were to evaluate, enhance and adapt existing biodiversity and nature management and conservation strategies in protected areas to respond proactively to climate change-related threats to habitat integrity and diversity. The project modelled the expected impact of climate change in a number of protected areas in Central Europe. Based on the model results, the project has prepared seven Climate Adapted Management Plans (CAMPs) for administrations of protected areas in four countries. The CAMPs enable national park authorities to better respond to threats aggravated by climate change, such as the increased spread of invasive species, drier climate, etc. The toolset and detailed guidelines enable the development of CAMPs for natural sites not covered by the project, thereby facilitating broader use of results. The United Nations Educational, Scientific and Cultural Organization's (UNESCO's) Man and Biosphere Programme selected HABIT-CHANGE as a 'good practice project'.

---

[154] https://www.keep.eu/keep/project-ext/15837/INCA-CE?ss=d22f933d259b11c3a9631d907be195e5&espon=

[155] http://www.inca-ce.eu

[156] http://www.eu-uhi.eu/

[157] http://www.habit-change.eu/

In line with the rather supporting role of adaptation in the current INTERREG Central Europe Programme 2014–2020, there is to date (June 2018) no approved project targeting anticipatory climate adaptation as a primary issue. All running projects with potential relevance to adaptation appear to deal with climate change impacts and adaptation mainly as a mainstreaming issue, a side theme or co-benefit in the context of sector policies, rather than adaptation being the core concern. In the following, this predominant pattern of transnational projects tackling problems that are exacerbated by climate change is illustrated by two selected examples with particular relevance to climate adaptation.

Responding to growing pressure due to the increasing frequency and intensity of local extreme precipitation events, the current project **RAINMAN** (Integrated Heavy Rain Risk Management)[158] (2017–2020) seeks to develop solutions against the effects of heavy rainfall events in a risk management context. The 10 partners from 6 countries are undertaking the following main activities: (1) developing methods to assess heavy rain risks and to support identification of high risk areas in urban and rural land use settings; (2) developing a joint strategy to reduce risks of heavy rain events, a catalogue of risk reduction measures, guidance for selection of best options, and guidance for implementation of measures; (3) pilot activities in 7 regions to test the feasibility of developed approaches and to optimise their performance and transferability. To improve the integrated risk management capacities of regional and local administrations, the results will be compiled in a comprehensive toolbox.

The ongoing project **PROLINE-CE** (Efficient Practices of Land Use Management Integrating Water Resources Protection and Non-structural Flood Mitigation Experiences)[159] (2016–2019), aims to improve the protection of drinking water resources as well as the protection of regions against floods and droughts in an integrated land use management approach, taking into account adaptation to pressures caused by climate change despite uncertain climate projections. Existing strategies, management plans and good practices will be implemented in 8 pilot areas. The following main lines of activity are underway: (1) peer review of current best land use management practices for drinking water resources in each country; (2) assessment of existing land use practices in terms of drinking water protection and the potential for improvement; (3) developing transferable guidance for implementation of best management practices for drinking water protection; (4) preparing a joint political declaration with targets for effective and efficient land use management practices ('DriFLU – Drinking Water/Floods/Land-Use-Charta'), to be signed by political representatives of each participating country.

4.1.8 Danube

The thematic foci of adaptation-related projects funded by the INTERREG DTP 2014–2020 and its predecessor, the INTERREG SEE Programme 2007–2013 (which at the same time is the precursor to Adriatic-Ionian and Balkan-Mediterranean Programmes 2014–2020), reflect that adaptation in the Danube region is mostly framed in the context of challenges to the management of flood risk, water resources, drinking water supply, and droughts.

The INTERREG South East Europe Programme 2007–2013 funded a range of projects dedicated to climate change impacts, risks and adaptation. The three selected projects presented in the following may be regarded as representative of the climate change-related problems tackled most frequently. Due

[158] http://www.interreg-central.eu/Content.Node/RAINMAN.html

[159] http://www.interreg-central.eu/Content.Node/Project-Summary.html

to its far-reaching strategic approach to improving transnational cooperation in flood risk management along the entire Danube River, the **DANUBE FLOODRISK** (Stakeholder oriented flood risk assessment for the Danube floodplains)[160] project (2009–2012) was labelled a flagship project for the SEE programme. Against the background of increasing flood risk with ongoing climate change, it focused on the most cost-effective measures for flood risk reduction: risk assessment, risk mapping, involvement of stakeholders, and risk reduction by adequate spatial planning. Based on a transnational assessment and mapping methodology, the 20 partners from 10 countries have developed a scalable system of flood risk maps for the Danube River floodplains, a manual on harmonising requirements for Danube river flood mapping, and a scoping study on integrating flood risk management into spatial planning. DANUBE FLOODRISK has proposed flood mitigation measures and raised the awareness of flood risk for stakeholders, politicians, planners and the public.

Focusing explicitly on adaptation, the **ORIENTGATE** (A network for integration of climate knowledge into policy and territorial planning)[161] project (2012–2014) aimed to coordinate climate change adaptation efforts. It developed a methodology for assessing risks of climate variability and change, has provided climate scenarios and indicators, contributed to harmonising risk assessments on the part of hydro-meteorological services, and encouraged inclusion of climate adaptation knowledge in territorial planning and development. The partnership, comprising 19 partners and 11 associated partners from 13 countries in total, explored climate risks faced by coastal, rural and urban communities in 6 regional pilot studies within three thematic clusters: forestry and agriculture; drought, water and coasts; and urban adaptation and health. A major objective was to communicate up-to-date climate knowledge for the benefit of policymakers, decision-makers and stakeholders.

Involving 15 partners (plus 2 associated partners) from 10 countries, the **CC-WARE** (Mitigating Vulnerability of Water Resources under Climate Change)[162] project (2012–2014) tackled increasing pressures on water resources caused by land use and climate change. It developed, among others, a common methodology for mapping vulnerability of water resources under climate change; transnational drinking water vulnerability maps; a criteria- and indicator-based assessment of ecosystem services in the SEE region; management options and recommendations for adaptive forest management, for water protected areas, and for improving water use efficiency and economic incentives for water management. Overall, results have been translated into an integrated transnational strategy for water protection and mitigating vulnerability of drinking water supply in the SEE region, which is accompanied by a framework for the development of national/regional action plans.

Given that water, represented most prominently by the shared Danube River, is the essential common resource of the region, projects funded by the Danube Transnational Programme 2014–2020 are expected to contribute to sustainable river basin and water resource management. Accordingly, the international coordination of policies related to water management within the framework of the Danube River Basin Management Plan (DRBM Plan) (ICPDR, 2015b) is identified as the main cooperation requirement under the theme 'Climate change and risk management' in the DTP cooperation programme (INTERREG Danube, 2017)[163]. In turn, the DRBM Plan lists ERDF, and more specifically the

[160] http://www.southeast-europe.net/en/projects/approved_projects/?id=67

[161] http://www.orientgateproject.org/

[162] http://www.ccware.eu/

[163] http://www.interreg-danube.eu/

Danube Transnational Programme and the Central Europe Programme, as potential key funding sources for financing implementation of its joint programme of measures (among other EU funding sources, such as the LIFE programme).

Up to June 2018, only a few projects funded by DTP 2014–2020 appear to have a clear relevance to CCA and DRR. All respective projects deal with river basin and water management issues from different perspectives. The **JOINTISZA** (Strengthening cooperation between river basin management planning and flood risk prevention to enhance the status of waters of the Tisza River Basin)[164] project (2017–2019) aims to further improve the integration of water management and flood risk prevention planning for the next river basin management planning cycle, in line with the relevant EU legislation. The project involves the joint efforts of the five countries that share the Tisza River Basin, including associated partners from Serbia and Ukraine. The International Commission for the Protection of the Danube River (ICPDR) Tisza Group as well as the EUSDR PA4 (Water Quality) and PA5 (Environmental Risks) coordinators are closely involved in activities. The Secretariat of the Carpathian Convention is an associated strategic partner and acts as advisor on issues related to climate change adaptation within the project.

Carried out by 14 partners (plus 8 associated partners) covering 10 countries, the **DriDanube** (Drought Risk in the Danube Region)[165] project (2017–2019) aims to increase the capacity of the Danube region to manage drought-related risks by providing the following key outputs: a Drought User Service, which will enable more accurate and efficient drought monitoring and timely early warning; harmonised methodologies for risk and impact assessments; and improved decision-making though introducing the drought management cycle. The project's main expected result is improved drought emergency response and better cooperation among operational services and decision-making authorities in the Danube region on national and regional levels. DriDanube supports implementation activities of priority area 5 on environmental risks of EUSDR and it contributes to the Integrated Drought Management Programme Central and Eastern Europe (IDMP CEE; see section 4.2).

In order to build the first knowledge base about climate change, climate impacts and adaptation and DRR options in the Carpathian region, a series of interlinked groundwork studies on climate change and adaptation and disaster risk reduction measures have been carried out. Following an initiative by the European Parliament and funded by the European Commission, a package of three projects[166] has provided the knowledge base for further adaptation efforts in the context of the Carpathian Convention. **CARPATCLIM** (Climate of the Carpathian Region)[167] (2010–2013) has harmonised historic climate data from 1961–2010. Its main aim was to improve climate data to investigate how the regional climate has changed over this period. It produced a freely available high-resolution database for the larger Carpathian Region. The **CARPIVIA** (Carpathian integrated assessment of vulnerability to climate change and ecosystem-based adaptation measures)[168] project (2011–2013) assessed the vulnerability to climate change of the Carpathian region's main ecosystems. The project produced an inventory of climate change effects and ecosystem-based adaptation measures. Finally, **CarpathCC** (Climate Change in the

[164] http://www.interreg-danube.eu/approved-projects/jointisza

[165] http://www.interreg-danube.eu/approved-projects/dridanube

[166] Summary information of the three projects are included under the Carpathian webpage of Climate-ADAPT: https://climate-adapt.eea.europa.eu/countries-regions/transnational-regions/carpathian-mountains/general/index_html

[167] www.carpatclim-eu.org

[168] www.carpivia.eu

Carpathian Region)[169] (2010–2014) examined the vulnerability of water, soil, forests, ecosystems and related production systems. It proposed tangible ecosystem-based adaptation measures, and it assessed their costs and benefits (Werners et al., 2014). The outcomes of the three projects have created an important knowledge base for further action on adaptation in the region.

4.1.9 Mediterranean

The INTERREG MED Programme 2007–2013 funded a range of projects, which among their foci included climate change adaptation to some of the most relevant challenges affecting this basin. In particular, climate change was considered within axis 2 'Environmental protection and promotion of a sustainable territorial development' which co-financed a wide range of thematic fields, particularly in the fields of energy, integrated management of coastal areas and forest issues (MED Programme 2007-2013, 2017). The first two projects presented in this section can be regarded as representative of the climate change-related challenges most frequently tackled by the 2007–2013 MED Programme, i.e. climate change impact on coasts and forests.

COASTGAP (Coastal Governance and Adaptation Policies in the Mediterranean) (2013–2015)[170] developed from more than ten years of shared experiences between various Mediterranean coastal administrations and institutions in the field of coastal adaptation to climate change and other natural or human-induced threats. COASTGAP capitalised on 12 best practices from 9 projects funded by MED (including for example **MAREMED** (MAritime REegions cooperating for the MEDiterranean)[171] (2010–2013) and **COASTANCE** (regional COmmon Action STrategy Against Coastal Erosion and climate change effects for a sustainable coastal planning in the Mediterranean basin)[172] (2009–2012) and other programmes, to underpin governance and adaptation policies which aim to reduce risk along coastal zones and foster their sustainable development. Based on the results of the capitalisation and supported by multi-level agreements, COASTGAP produced the 'Joint Action Plan on Med coasts Adaptation to Climate Change' (JAP)[173] aiming to provide an operational and coherent strategy for the 2014–2020 financial period. The JAP identifies a number of initiatives (studies, researches, projects, communication actions, dissemination actions, clustering, etc.) encompassed by the general Macro-Project outlined by the Bologna Charter 2012[174].

FOR CLIMADAPT (Adaptation of Mediterranean woodlands to climate change impacts)[175] (2010–2013) involved partners from five Mediterranean countries (France, Italy, Spain, Greece and Portugal) and focused on climate-related impacts on Mediterranean forests, specifically: fire, dieback and soil erosion. Based on pilot activities implemented on particular sites, the project enabled partners to share successful and innovative solutions that foster climate change adaptation and to develop a

[169] www.carpathcc.eu

[170] http://www.programmemed.eu/en/the-projects/project-database/results/view/single.html?no_cache=1&idProject=61

[171] MAREMED (2010–2013) focused on coastal and maritime issues characterised by a relevant transnational dimension: data management, fisheries, governance, climate change adaptation in coastal areas, pollution and ICZM; http://www.maremed.eu/index.php

[172] COASTANCE (2009–2012) developed practical (technical/administrative) tools to manage the coastal zone adaptation to climate change; https://www.keep.eu/keep/project-ext/3921/COASTANCE?ss=f8b0f7073dc187aa0aaa8959c95eff51&espon=

[173] http://www.bolognacharter.eu/the-joint-action-plan

[174] http://www.bolognacharter.eu

[175] https://www.keep.eu/keep/project-ext/4004/FOR+CLIMADAPT?ss=0acd9cc8a74a5aca9229dab9c6079114&espon=

Mediterranean strategy that aims to improve forest adaptation capacity taking into account four complementary approaches: (1) observation and monitoring of modifications occurring in the ecosystem; (2) development of new forestry which promotes heterogeneity while maintaining the economic value; (3) methods for ecological restoration of degraded lands (afforestation, bio-engineering, etc.); (4) awareness of society and improving governance.

The MED Programme 2007–2013 also supported studies on climate change adaptation on contexts with coastal areas and forests, as in the case of the project **CAT-Med** (Change Mediterranean metropolises Around Time)[176] (2009–2011), which involved partners from various Mediterranean cities (Malaga, Seville, Valencia, Barcelona in Spain, Marseille Aix urban area in France, Turin, Genoa, Rome in Italy, and Athens and Thessaloniki in Greece). Based on pilot studies, CAT-Med provided a common model of sustainable urban development in the Mediterranean that aims to contribute to the prevention of natural risks related to climate change, and to define common actions to put this model into practice. A methodological guide for Sustainable Urban Districts was also produced.

Similar to the previous programming period, as at June 2018 the MED programme 2014–2020 has not yet funded projects directly dealing with the cross-sectoral dimension of climate change adaptation. However, it has focused, directly or indirectly, on some specific climate change issues, continuing on from 2007–2013 projects. Integrated management of coastal areas is one of the topics addressed by the project **CO-EVOLVE** (Promoting the co-evolution of human activities and natural systems for the development of sustainable coastal and maritime tourism)[177] (2016–2019). Involving partners from 5 Mediterranean countries (Spain, France, Italy, Croatia, Greece) CO-EVOLVE aims to analyse and promote the co-evolution of human activities and natural systems in tourist coastal areas, confronting the effects of climate change and allowing sustainable development of tourist activities, in coexistence and synergy with other users of the coastal and marine space and resources, based on the principles of ICZM and Maritime Spatial Planning (MSP). Project activities will develop: (1) an integrated analysis, at the Mediterranean and pilot area scales, of the principal threats (including climate change and sea level rise) and enabling factors for a sustainable development of coastal tourism, (2) a quali-quantitative analysis of the sustainability of tourism in pilot areas, developing a tourism sustainability toolkit, and (3) tourism-oriented strategic action plans for each pilot area, including operative guidelines.

Biodiversity protection and enhanced nature conservation are among the key objectives of the current MED Programme[178]; a number of projects have been funded on these issues, including one that specifically deals with climate change adaptation. Beginning with the consideration that Marine Protected Areas (MPAs) can play an important role in climate change mitigation and adaptation, **MPA-ADAPT** (Guiding Mediterranean MPAs through the climate change era: building RESILIENCE and ADAPTATION)[179] (2016–2019) aims to: (1) raise awareness of the role of effective MPAs for enhancing resilience to climate change and safeguarding ecosystem services as well as contributing to adaptation measures; (2) strengthen capacity of MPAs to plan for and respond to climate change impacts based on a better understanding of climate risk and vulnerability; (3) showcase how climate change can be integrated into planning and management of Mediterranean MPAs. Five MPAs from three

[176] https://www.keep.eu/keep/project-ext/3918/CAT-Med?ss=bb7a168f3cbfd25f9d0d99ccf2511fe7&espon=

[177] https://co-evolve.interreg-med.eu/

[178] https://biodiversity-protection.interreg-med.eu/

[179] https://mpa-adapt.interreg-med.eu/

Mediterranean countries act as pilot sites (Brijuni National Park in Croatia, Pelagie Islands MPA in Italy, Portofino MPA in Italy, Bonifacio Strait Nature Reserve in and Port-Cros National Park in France) for the development of climate change adaptation action plans and their integration into existing management frameworks. Expected results of the project also include monitoring protocols for climate change impacts, local science-based stakeholder dialogues, capacity building initiatives, and a regional framework plan for long-term monitoring of the impacts of climate change in Mediterranean MPAs.

Apart from the MED Programme, other EU and international funding programmes contribute to transnational knowledge creation and transfer of adaptation practice in the Mediterranean area, also involving non-European countries. This is the case of the EU ENI Cross-Border Cooperation Mediterranean 2014–2020 and the former ENPI Cross-Border Cooperation Mediterranean (CBCMED) 2007–2013 programmes, which also included climate change among their foci. Similarly to the INTERREG MED, ENPI CBCMED 2007–2013 funded some projects that deal with specific climate change aspects, for instance, **ACCBAT** (Adaptation to Climate Change through improved water demand management in irrigated agriculture by introduction of new technologies and best agricultural practices)[180] (2012–2015) and **MEDSANDCOAST** (Modèles innovants de gouvernance des ressources des zones cotières-marines pour une défense stratégique des littoraux Méditerranéens – Innovative models for the governance of the resources of coastal and marine areas for the strategic protection of Mediterranean littorals)[181] (2013 – 2016).

UNEP/MAP also played a role in sharing knowledge and practices also related to climate change impact assessment and adaptation in the Mediterranean region (and in particular toward non-EU countries). A good example of UNEP/MAP activities on knowledge creation and sharing is the project **ClimVar & ICZM** (Integration of climatic variability and change into national strategies to implement the ICZM Protocol in the Mediterranean)[182] (2012–2015), involving international organisations (the PAP/RAC[183] and Plan Blue[184] Regional Activity Centres of UNEP/MAP and global Water Partnership (GWP)-Med and the countries of Albania, Algeria, Bosnia and Herzegovina, Croatia, Egypt, Libya, Morocco, Montenegro, Palestine, Syria and Tunisia. ClimVar&ICZM aims to: (1) strengthen knowledge on regional climate variability and change and on their impacts, defining their specific characteristics in the Mediterranean region; and (2) improve capacity building and establish mechanisms for exchange of data and information for integration of climate variability and put into practice ICZM policies, plans and programmes. A report on risk assessment for the Mediterranean coastal areas (Satta et al., 2015) and two relevant methodological documents resulted from the project: one integrates adaptation into coastal planning and management, and the other provides guidance on socio-economic assessments of the potential costs caused by climate variability and change. In the framework of this project, PAP/RAC supported development of the coastal plan for the Šibenik-Knin County[185] in Croatia with a focus on climate variability and change; this plan aims to build resilience to climate change for this coastal region and might be considered good practice to be capitalised in other Adriatic-Ionian coastal areas.

[180] http://accbat.eu/

[181] https://www.keep.eu/keep/project-ext/41552/MEDSANDCOAST

[182] https://pap-thecoastcentre.org/projects/cv.html; this site is focused on PAP-RAC activities within ClimVar&ICZM, providing also valuable information on the entire project. ClimVar&ICZM website is not available anymore.

[183] http://www.paprac.org/

[184] http://planbleu.org/en

[185] https://pap-thecoastcentre.org/projects/

Moreover, ClimVar&ICZM developed the 'Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas', adopted by COP 19 in 2016 (see section 3.9).

4.1.10 South West Europe

Efforts to create a shared understanding of the effects of climate change in the SUDOE region have been spearheaded by the INTERREG IV B-funded ADAPTACLIMA (Adaptation aux effets dérivés du changement climatique) (2009–2011) and the follow-up ADAPTACLIMA II (Adaptation au Changement Climatique dans le SUDOE) (2011–2013) projects[186]. Involving 9 partners in 3 countries (Spain, France and Portugal), ADAPTACLIMA aimed to: (1) conduct a shared assessment of climate change impacts on the territories and socioeconomic sectors of each involved region, including water resources, housing, agriculture, forestry, livestock, fishery, aquaculture, tourism; (2) define and promote consistent adaptation measures; and (3) increase public awareness about climate change.

With the aim of capitalising on the resulting studies, conclusions and recommendations, the follow-up project ADAPTACLIMA II implemented four pilot projects:

- A multi-temporal viewer of alterations to the landscape produced by climate change developed by the Regional Government of Andalusia;
- A laboratory for the implementation of adaptation measures in protected nature areas in Cantabria;
- A downscaling of climate change scenarios for Andalusia based on the programmes, methods, and procedures designed in ADAPTACLIMA;
- A thermal diagnosis during summer months in several SUDOE urban areas to devise renewable resource-based solutions to optimise comfort in residential and work areas.

Results from the pilots were then transferred to other areas in the SUDOE region through so-called 'capitalisation groups'. Particular efforts were directed into reaching a diverse audience through training and awareness campaigns, including public managers, business and agricultural representatives, and the general public.

Under the current INTERREG V B programme 2014–2020, attention has been devoted to two key challenges the SUDOE region has to face: water management and the protection of forest areas. The first issue has been dealt with within Axis 1 on 'Research and innovation', where both the **4KET4Reuse**[187] (KET for treated wastewater reuse in water scarcity SUDOE regions) (2016–2019) and **AGUAMOD**[188] (Development of a water resource management platform in low-water periods in SUDOE territory) (2016–2019) projects have been funded. The former aims to develop Key Enabling Technologies (KET) for the reuse of wastewater to tackle water scarcity, which in the region is mainly driven by decreasing precipitation and the pollution of available resources. In particular, the project seeks to develop and validate four regeneration systems by eliminating emerging pollutants. The AGUAMOD project aims to develop a platform for the integrated management of water resources in the SUDOE during summer periods as a tool for strengthening cooperation between managers and land users.

[186] http://www.adaptaclima.eu/en

[187] https://en.4ket4reuse.eu/home

[188] http://www.aguamod-sudoe.eu/en

The second key challenge, namely increasing the resilience of forests against climate-related multiple threats, represents the current focus of axis 4 'Combating climate change'. The objective of the **FIRE-RS** project (wildFIRE Remote Sensing)[189] (2016–2019) is to reduce the impacts of forest fires by providing emergency agencies and coordination centres with an innovative tool for the early detection and efficient management of fires. On a different note, **PLURIFOR** (Transnational Plans for the Management of Forest Risks)[190] (2016–2019) seeks to reduce the vulnerability of woodland areas to multiple hazards (plagues, diseases, storms, and fires) by creating or improving management plans in Spain, France, and Portugal.

Cross-border cooperation also plays an important role in building a joint knowledge base, and to transfer, replicate and capitalise on adaptation knowledge. This is exemplified by the support provided to OPCC (see section 4.2) research activities by the INTERREG A POCTEFA Cross-Border Cooperation Programme both under the previous and current programming period. The **OPCC** project[191] (2012–2014) supported a number of actions, including: (1) the implementation of methodological tools and techniques to develop Pyrenees climatology; (2) the development of indicators for monitoring the effects of climate change on biodiversity; (3) the study of the impact of climate change on Pyrenees forest ecosystems and the role of forests in mitigating natural hazards. With respect to adaptation, the project included a dedicated vulnerability assessment of the Pyrenean territory to climate change. Based on this, an inventory of relevant adaptation initiatives in the region and beyond was created and recommendations for integrating climate change considerations into projects and policies developed (OPCC and CTP, 2013). The project also allowed for creation of a transboundary network of institutions and research entities that work on different adaptation-related aspects, including biodiversity, forests, natural hazards, highly vulnerable ecosystems and climate variability. The follow up **OPCC–2** project[192] (2016–2019) will enhance current knowledge on climate change impacts and vulnerabilities in the Pyrenees, and support decision-making by identifying and implementing adaptation measures.

4.1.11 Adriatic-Ionian

In the 2007–2013 period, transboundary cooperation in the region was supported by two funding programmes: (1) the INTERREG South East Europe (also overlapping with geographic scope of the current INTERREG Balkan-Mediterranean and the Danube Transnational Programmes) and (2) the INTERREG Adriatic IPA Cross-Border Cooperation programmes.

As shown in the Danube region, the first programme played an important role in funding projects on climate change impacts, risks and adaptation, which are also relevant for the Adriatic-Ionian region. With reference to the examples mentioned in the section of this chapter on the Danube region (section 4.1.8), it is worth noting that the **ORIENTGATE** project involved seven (out of eight) Adriatic-Ionian countries (Albania, Bosnia and Herzegovina, Croatia, Greece, Italy, Montenegro and Serbia), while the **CC-WARE** project, which focused on water resources, included partners from six countries from this region (Bosnia and Herzegovina, Croatia, Greece, Italy, Slovenia and Serbia). As for CC-WARE, the project **CC-WaterS**

[189] http://www.fire-rs.com/en

[190] https://plurifor.efi.int/

[191] https://www.keep.eu/keep/project-ext/21668/OPCC?ss=5a1af116a18549c0eac536facfe5062a&espon=

[192] https://opcc-ctp.org/en/opcc

(Climate Change and Impacts on Water Supply)[193] (2009–2012) also focused on water-related aspects, involving partners from nine countries in total, five of which are included in the Adriatic-Ionian region (Croatia, Greece, Italy, Slovenia and Serbia). CC-WaterS evaluated climate change impacts on the availability and safety of public drinking water supply in the South East Europe region and explored measures to adapt to those impacts, thus building a Water Supply Management System which includes optimisation of water extraction and land use restrictions.

Box 4.2: The SEE Forum on Climate Change Adaptation – (SEEFCCA)

The 'SEE Forum on Climate Change Adaptation'(**SEEFCCA**[194]) was created through a project (2011–2012) funded by the IPA South East Europe Transnational Cooperation Programme 2007–2013. The Forum consisted of four national Civil Society Organisations (CSO) networks: Croatian network, FYROM network 'Climate Reaction', Montenegrin network 'Climate Response', and Serbian network 'Climate Forum'. The overall objective of this Forum was to enable a broad range of stakeholders (civil society actors, government authorities, international organisations, scientists and the Red Cross) to discuss climate change adaptation, disaster risk reduction and preparedness issues in a transnational context. The SEEFCCA website provides access to documents developed for the region covered by the four involved countries, including the regional climate vulnerability assessment report and national climate vulnerability assessments.

Climate change adaptation is considered under priority axis 2 of the INTERREG V B ADRION Programme 2014–2020. Prior to June 2018, ADRION launched a call that resulted in 33 projects, which mostly started at the beginning of 2018. Among these, I-STORM (Integrated Sea sTORm Management Strategies)[195] (2018 – 2019) seems to be the only project directly dealing with climate change related issues. The main aim of I-STORM is to enhance the sharing of data, forecasts and knowledge on sea storms and related impacts (coastal flooding, erosion and consequent impacts on coastal ecosystems and infrastructure) through a common infrastructure and tools (e.g. for coastal disasters mapping and for hazard and risk assessment). Moreover, the project aims to develop joint strategies for ensuring effective response to sea storm emergencies, also by improving countries' capacities to share data and information, early warning and civil protection procedures. The permanent cooperation network set up by the project wishes to ensure that sea storm challenges are faced and overcome in the framework of EUSAIR and with a medium-term implementation perspective.

Similarly to ADRION, the Italy-Croatia Cross-Border Cooperation Programme 2014–2020[196] has funded an initial set of projects. This CBC programme is particularly relevant for the Adriatic-Ionian region as the cooperation area (25 provinces in Italy and 8 counties in Croatia) covers a significant portion of the Adriatic sub-region and it deals directly with the issue of climate change adaptation. Indeed, the strategic objective 2.1, part of priority axis 2 'Safety and resilience', focuses on improving climate change

[193] http://www.ccwaters.eu

[194] http://www.seeclimateforum.org/CCA-Forum/1/Home.shtml

[195] http://www.ismar.cnr.it/progetti/progetti-internazionali/progetti-in-corso-cte-interreg/progetto-i-storms

[196] http://www.italy-croatia.eu/

monitoring and planning of adaptation measures. In particular, it intends to develop adaptation capacity against the main effects of climate change (sea level rise, flooding, accelerated coastal erosion, etc.) through a more integrated approach based on the added value given by cross-border cooperation. Of the three projects co-funded up by June 2018 by the Italy-Croatia Cross-Border Cooperation Programme under axis 2, **iDEAL** (DEcision support for Adaptation pLan)[197] (2018–2019) will support local authorities to manage climate-related problems. The project will develop and test a common evaluation framework of climate change impacts based on indicators, and will develop climate adaptation plans in five Italian and Croatian coastal areas. The other two projects funded within axis 2 are mainly related to DRR and the management of todays' extreme events and related risks. **AdriaMORE** (Adriatic DSS exploitation for MOnitoring and Risk management of coastal Extreme weather and flooding)[198] (2018–2019) will improve an existing platform on hydro-meteorological risk management, focusing on the Adriatic coastal areas of the two involved countries, while fire risk will be one of the key topics addressed by the project **Readiness** (Resilience Enhancement of ADriatic basiN from firE and SeiSmic hazards)[199] (2018–2020).

4.1.12 Balkan-Mediterranean

The situation of knowledge creation and sharing on climate change adaptation through cooperation projects in the newly established Balkan-Mediterranean region is very similar to that of the Adriatic-Ionian. Most of the countries cooperating in this programme collaborated under some of the previously mentioned projects funded by the INTERREG South East Europe 2007–2013 programme, as in the case of **ORIENTGATE** project which involved all Balkan-Mediterranean countries apart from Cyprus (Albania, Bulgaria, FYROM and Greece), or **CC-WARE** and **CC-WaterS** which includes partners from Bulgaria and Greece. As a result, although the cooperation region is fairly new in the framework of the INTERREG family, it can rely on a history of good cooperation experience on climate change topics.

The INTERREG V B Balkan-Mediterranean 2014–2020 Programme follows-up on this tradition, recognising climate change and the improvement of climate change adaptation as key challenges for the entire area. A number of projects launched at the end of 2017 within the frame of the programme deal with climate change and/or DRR, although they tend to focus on specific climate change-related impacts (e.g. heavy precipitation, drought, wildfire and coastal erosion) and tools (in particular including early warning systems and modelling toolkits). Some examples are reported below.

BeRTISS (BalkanMed real time severe weather service)[200] (2017–2019) involves partners from three countries (Greece, Cyprus and Bulgaria) and aims to develop a pilot transnational severe weather service to enhance the safety, the quality of life and environmental protection in the Balkan-Mediterranean region. The service is expected to provide timely information and warnings regarding severe weather events (in particular heavy precipitation events) as well as long-term monitoring of weather and climate change in the region. It builds on the Global Navigation Satellite Systems (GNSS) meteorology knowledge derived from previous relevant European research projects. A new GNSS analysis centre will be installed in Cyprus for the processing of GNSS tropospheric products and the computation of meteorological severe weather parameters. Derived products will be displayed in real time on a dedicated web-

[197] http://www.italy-croatia.eu/sites/default/files/ideal_27739482_1.pdf

[198] http://www.italy-croatia.eu/sites/default/files/adriamore_27712752_2.pdf

[199] http://www.italy-croatia.eu/sites/default/files/readiness_27739178%281%29.pdf

[200] http://www.interreg-balkanmed.eu/approved-project/14/

platform. Early warning is also the focus of the project **DISARM** (Drought and fIre ObServatory and eArly waRning systeM)[201] (2017–2019), which involves partners from the same countries that contribute to BeRTISS. The two projects are complementary, as DISARM focuses on different climate-related impacts (drought and wildland fires) and aims to deliver an integrated observatory platform and an early warning system to support their prediction and promote their prevention. The warning system will be based on the use of high-resolution meteorological forecasts, forest-fire spread models, satellite data for the detection of fires and the estimation of biomass, surface observations and monthly forecasting systems. DISARM will not only contribute to the prediction of drought and wildland fire risk in the Balkan-Mediterranean area, but will also assess related risks under a changing climate. Wildfires events are acknowledged as one of the most pertinent risks in the region and their early detection is the focus of the project **SFEDA** (Forest Monitoring System for Early Fire Detection and Assessment in the Balkan-Med area)[202] (2017–2019).

Partners representing of all the four coastal Balkan-Mediterranean countries contribute to the project **HERMES** (A Harmonised fRamework to Mitigate coastal EroSion promoting ICZM protocol implementation)[203] (2017–2019). In this region, the impact of winter storms, the effect of sediment blockage due to river damming, the degradation of beach stability in areas of urban and tourist activities and the lack of an integrated approach in human interventions along the coast have led to significant coastal erosion rates. Capitalising on previous INTERREG projects (e.g. BEACHMED, COASTGAP, COASTANCE), HERMES aims to develop a common framework for coastal erosion mitigation and beach restoration through the implementation of a coherent ensemble of studies, the sharing of already developed technical tools and the design of joint policy instruments. The framework will be tested in four sites, including evaluation of historic and future coastal dynamics, definition of erosion and climate change vulnerability indicators, evaluation of human-related pressures, organisation of collected data in a Web-Geographic information System (GIS), application of a modelling toolkit (including meteorological, hydrodynamic, wave and morphodynamic modules), and evaluation of a series of intervention scenarios to cope with current and future coastal erosion, including in particular measures based on green infrastructure (beach and dune stabilisation, beach nourishment, etc.).

4.2 Knowledge platforms and centres

As adaptation policy progresses in Europe, it is increasingly important that decision-makers and stakeholders have access to relevant and high-quality information. The latter can be used to support the development and implementation of transnational adaptation strategies, plans and measures. A broad range of users considers web-based climate change adaptation platforms an effective means of collecting, assimilating and communicating relevant evidence, experience and knowledge to interested stakeholders including policymakers, practitioners and the general public (EEA, 2015).

At EU level, guidance, knowledge and experience regarding all steps of the adaptation policy planning and implementation are shared via Climate-ADAPT, the European Climate Adaptation Platform. This freely accessible platform was launched in 2012 as a partnership between the European Commission (in particular Directorate General for Climate Action (DG CLIMA)) and the European Environment Agency to

[201] http://www.interreg-balkanmed.eu/approved-project/16/

[202] http://www.interreg-balkanmed.eu/approved-project/22/

[203] http://www.interreg-balkanmed.eu/approved-project/18/

overcome the lack of a consistent knowledge base on adaptation in Europe. It is maintained by the European Environment Agency (EEA) with the support of the European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation (ETC/CCA). Its main task is to inform its users about adaptation policy at EU level and provide an entry point to other sources of adaptation information in Europe. The EU Adaptation Strategy recognised Climate-ADAPT as a key element for better-informed decision-making and emphasises its potential to act as the 'one-stop shop' for adaptation information in Europe (EEA, 2018a).

The 'Climate-ADAPT section on European transnational regions' provides overview of information about the policy frameworks and initiatives, including those related to knowledge creation and sharing, and was put in place to enforce and strengthen cooperation on climate change adaptation at the transnational level. The section acts as a gateway to sources of more detailed information. Moreover, the countries being Parties to the Carpathian Convention agreed to further contribute to Climate-ADAPT by providing data and information, under the coordination of the Secretariat. A specific additional section on the Carpathian area 'Adaptation in Carpathian Mountains' under the 'transnational regions' web page of Climate-ADAPT was created and presented during the 5th Conference of the Parties to the Carpathian Convention (Lillafüred, Hungary, October 2017). Similarly, a specific section on CCA in the Baltic Sea region 'Adaptation in Baltic Sea Region' under the 'transnational regions' web page of Climate-ADAPT was developed as proposed by the BSR Climate Change Dialogue Platform. It is operated and regularly updated by Baltic 2030 Unit of the Council of the Baltic Sea States Secretariat, with information on policy frameworks, impacts, vulnerabilities and adaptation measures.

Although the number of web-based adaptation platforms at the transnational level is still limited and concentrated in few regions (namely the Alpine and Pyrenees mountain regions), the existing sites provide remarkable examples on how countries could cooperate to develop these knowledge sharing instruments, also in the frame of INTERREG cooperation programmes, EU macro-regional strategies and/or other structured cooperation initiatives.

One of the most notable examples of an adaptation platform at transnational level is provided by the online knowledge sharing infrastructure **CAPA** that was developed in the frame of the INTERREG Alpine Space project C3-Alps[204] (2011–2014; see section 4.1.6). CAPA is a transnational adaptation knowledge portal covering the entire Alpine macro-region and the territories of all Alpine countries. It occupies an otherwise vacant niche among adaptation repositories and intends to fill the gap between Climate-ADAPT on the pan-European level and national portals in this region, which are restricted to items relevant to the respective national context only. The knowledge resources cover multiple scales from transnational to municipality level, contain items in English and all Alpine languages, and cover all relevant adaptation sectors, types of knowledge products, and process stages of the adaptation policy cycle.

Contents, structure, functionalities and web design are tailored to match information needs and communication profiles of core target groups: public administration, municipal actors, and the expert and consultancy community. From 2017 onwards, the full deployment, extension, maintenance and evaluation have been taken up by the work plan of EUSALP Action Group 8[205] on 'Risk Governance'.

[204] http://www.alpine-space.org/2007–2013/projects/projects/detail/C3-Alps/show/index.html

[205] https://www.alpine-region.eu/action-group-8

CAPA is currently managed by the Environment Agency Austria and Spatial Services GmbH on behalf of the Austrian AG8 co-leader Federal Ministry of Sustainability and Tourism (BMNT) under the umbrella of EUSALP. CAPA has been relaunched under a new EUSALP-related domain[206]. Corresponding with the double thematic focus of AG8, a particular focus of future content enhancement will be on knowledge resources cutting across the climate adaptation and disaster risk reduction policy fields.

Another example comes from the Pyrenees region, most likely driven by the high vulnerability of this mountain region to climate change and the related long-standing experience of cooperation on climate change adaptation. The **OPCC**[207] was created in 2010 by CTP. The CTP was established in 1983 with the support of the Council of Europe to provide the Pyrenees with a structure of cross-border cooperation; it currently involves Euskadi (Basque Country), Navarra, Aragon and Catalonia in Spain, Andorra and Novelle-Aquitaine and Occitanie Pyrénées-Méditerranée in France. The OPCC aims to promote a better understanding of climate change impacts in the region and to define effective adaptation measures. Work on adaptation so far has included:

- A vulnerability analysis of the region to climate threats;
- A database of best practices on adaptation to climate change in mountain areas;
- The definition – together with relevant stakeholders, decision-makers and authorities – of recommendations for the strengthening and implementation of coordinated medium-term initiatives throughout the Pyrenees.

The Observatory coordinates the OPCC–2 project funded by POCTEFA Programme 2014–2020 (see section 4.1.10), which specifically aims to cover climate change impacts knowledge gaps and outline adaptation options for the Pyrenees region. A stakeholder network was also created within the observatory as a way to involve institutions and research entities working on different aspects related to climate change adaptation, including biodiversity, forests, natural hazards, highly vulnerable ecosystems and climate variability. From September 2017 to June 2019, OPCC will carry out 6 socio-economic sectoral workshops in Spain France and Andorra, in order to capture the perception of climate change risks for cross-border socioeconomic sectors, and to involve them in the prompt definition of sectoral adaptation initiatives through participative processes.

The governance scheme of OPCC is structured around a Technical Committee, a Steering Committee and an Advisory board. The technical committee is composed of representatives of the 7 territories of CTP, and provides guidance and sets priorities for OPCC. The Steering Committee is made up of the partners of the project and is responsible for implementing the different project actions, ensuring the definition of common protocols concerning climate change impacts indicators and databases, and sharing of relevant climate information.

With a specific view on the particular knowledge needs of the coastal ecosystems represented by the Dutch, German and Danish Wadden Sea area, the Secretariat of the Trilateral Cooperation on the protection of the Wadden Sea maintains an online **Climate Adaptation Knowledge Platform**[208]. This platform provides information relevant for the climate change adaptation strategies focusing on the

[206] http://www.capa-eusalp.eu

[207] https://opcc-ctp.org/en

[208] http://www.waddensea-secretariat.org/tgc/documents

specific scope of conservation ecosystems such as the Wadden Sea, linking to documents, reports, web sites and data related to best practice descriptions, policy and management, monitoring and assessment, and communication and education cases.

Centres and networks also play a role in knowledge-sharing. They partially differ from knowledge platforms as the web-based interface is not their main component; indeed, in some cases the web component of the knowledge centre or network is a simple website. However, it should be be noted that the difference between knowledge centres / networks and adaptation platforms is not always clear. In this paper, we focus on centres and networks that share data, information and services, which aim to directly support the development of climate change adaptation initiatives (strategies, plans, measures, etc.) at the transnational level, therefore also implying a significant role of transboundary cooperation in their creation and management. Research-based centres and networks are not considered by this study; however some examples of these initiatives are illustrated in the Box 4.3.

Examples of structured knowledge centres, networks and initiatives are more numerous than those of adaptation platforms. However, these initiatives are rather heterogeneous in scope. Few of them deal with the cross-cutting and cross-sectoral dimension of climate change adaptation. From this perspective, a relevant example is the **ECRAN**[209] funded by the EU and managed by the EC, which in 2013–2016 assisted Balkan beneficiaries (Albania, Bosnia and Herzegovina, Croatia, FYROM, Serbia and Kosovo under UN Security Council Resolution 1244/99, Montenegro, and Turkey) in the exchange of information and experience on environmental and climate issues relevant for preparation for accession to the EU. ECRAN built on experience gained and results achieved by the previous RENA (Regional Environmental Network for Accession) programme, running from 2010 to 2013, and aimed to:

- Continue strengthening regional cooperation in the fields of environment and climate action;
- Assist the beneficiary countries on their way towards the transposition and implementation of the EU environmental and climate policies and instruments, which is a key precondition for EU accession.

ECRAN included three components: an environment component, a climate action component and the NGOs Environment Forum. ECRAN activities under each component were implemented through a system of Working Groups, which in the case of the climate action component were:

- WG1 – Climate policy development and building climate awareness;
- WG2 – GHG inventory systems and EU monitoring mechanism regulation;
- WG3 – Emission trading system;
- WG4 – Climate adaptation.

Within the Working Group on Climate Adaptation, ECRAN promoted 'climate-proofing' actions by further encouraging adaptation in key vulnerable sectors, supporting better informed decision-making by addressing knowledge gaps on adaptation and promoting actions to ensure that infrastructure is made more resilient. A regional ECRAN Platform on Adaptation started to work on national adaptation planning using the steps advocated in the EU Adaptation Strategy and Adaptation Support Tool (AST)

[209] http://www.ecranetwork.org. Two extended brochures have been developed to illustrate ECRAN objectives and activities (ECRAN, 2016, 2017)

available on Climate-ADAPT. Through a series of thematic workshops, also involving Member States experts, the beneficiary representatives strengthened their knowledge of best practices in assessing climate change adaptation options, enhanced their understanding about their own country's climate change adaptation priorities and developed an initial vision about the implementation of prioritised climate change adaptation options. Promotion of climate-proofing actions focused on the following key vulnerable sectors: agriculture, water management, physical planning and energy. A follow-up project to ECRAN is currently under preparation[210].

The **BSR Climate Dialogue Platform**[211] is another remarkable example of a regional initiative with wider thematic scope. It is a flagship in the HA Climate of the EU Strategy for the Baltic Sea Region. It organises a series of round tables on climate change adaptation with national representatives, climate scientists and stakeholders in the Baltic Sea region. Prior to June 2018, seven round tables had been organised since the end of 2013. The BSR Climate Dialogue Platform contributes to the implementation of EU climate policies, promotes cooperation in the area of climate change adaptation, informs about policy development, catalyses exchange of information and best practices, fosters synergies among existing initiatives, explores further cooperation opportunities and contributes to the identification and development of concrete joint initiatives. Participating organisations are relevant national ministries and agencies from the Baltic Sea countries, transnational organisations in the region and European institutions. The BSR Climate Dialogue Platform (including workshops) is financed by three main sources: (1) the Baltic Sea INTERREG programme 2014–2020, as a part of the programme's support to the coordinators of EUSBSR; (2) annual contribution of member countries of CBSS to CBSS Baltic 2030; and (3) partly by the Ministry of the Environment that hosts the Climate Dialogue round-table meeting.

High vulnerability and evidence of climate-related impacts already happening might be drivers for the development of knowledge sharing initiatives in specific regions, including the Arctic. The **Arctic Portal**[212] is a comprehensive gateway established in 2006 that aims to increase information and data sharing. It is operated in consultation and co-operation with members of the Arctic Council and its working groups, permanent participants (such as councils and associations of indigenous peoples), observers (currently 13 non-Arctic states) and other stakeholders. Being a network of information and data sharing, it serves as host to many websites, supporting cooperation and outreach in science, education, and policymaking. The portal is managed as a non-profit organisation from Iceland, and operates under an international board of directors. The portal contains libraries and descriptions of political and science organisations, policy documents and agreements, many of which are particularly relevant for climate change adaptation. It also includes five portlets on specific Arctic-related issues, one of which specifically deals with climate change[213].

The **Arctic Adaptation Exchange**[214] **portal** facilitates knowledge sharing between communities, researchers and decision-makers on the pressing issues of climate change. It has three main sections:

[210] http://ec.europa.eu/environment/enlarg/reg_cooperation.htm

[211] http://www.cbss.org/strategies/horizontal-action-climate/ > Climate Dialogue

[212] https://arcticportal.org

[213] https://portlets.arcticportal.org/climate-change-and-sea-ice-portlet

[214] arcticadaptationexchange.com

1. Explore how others in the Arctic region have responded to the challenges and opportunities presented by climate change;
2. Share experiences and information on climate change impacts and adaptation initiatives and tools;
3. Connect with others who have experience and knowledge.

The portal was initiated by the Arctic Council's Sustainable Development Working Group (SDWG). Both the Arctic portal and the Arctic Adaptation Exchange portal have a circumpolar regional scope and hence provide information beyond the regional extent of the Northern Periphery and Arctic EU macro region.

Other centres, networks and initiatives tend to focus on specific climate-related risks. The **Drought Management Centre for South East Europe (DMCSEE)**[215] coordinates and facilitates the development, assessment and application of drought risk management tools and policies in South-Eastern Europe with the goal of improving preparedness and reducing drought impacts in this region. The idea of developing a knowledge centre focused on drought risks and related climate change impacts in the region of south-eastern Europe rose in the late 1990s and was supported by the 13 countries of the region (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, FYROM, Greece, Hungary, Moldova, Montenegro, Romania, Serbia, Slovenia and Turkey). The idea was further explored by the International Commission on Irrigation and Drainage (ICID) and the UN Convention to Combat Desertification (UNCCD). In 2006, the Slovenian Environmental Agency, which still operates as main DMCSEE contact point, was entrusted with organisation of DMCSEE work. As a first step, it was essential to obtain the necessary resources to set up the centre. To this end, DMCSEE submitted a successful application to the South East Europe Transnational Cooperation Programme 2007–2013, involving 15 partners from nine countries in the region that collaborated to enable the creation of the centre (Alexandris et al., 2012). The Centre is currently funded by the 13 countries of south-eastern Europe, UNCCD and WMO (World Meteorological Organization). The DMCSEE is therefore the result of a long-standing cooperation effort on drought-related issues. It plays a relevant supporting role for various transnational regions, mainly: Adriatic-Ionian, Balkan-Mediterranean and Danube.

Drought is also the focus of another cooperation initiative covering an area neighbouring (and partly overlapping with) the DMCSEE geographic coverage. The **IDMP CEE**[216] is one of three regional initiatives of the Integrated Drought Management Programme[217,] which is a joint initiative of the World Meteorological Organization (WMO) and GWP. IDMP in Central and Eastern Europe supports the governments of Bulgaria, the Czech Republic, Hungary, Lithuania, Moldova, Poland, Romania, Slovakia, Slovenia and Ukraine in the development of drought management policies and plans. It also builds on stakeholders' capacity at different levels for proactive integrated drought management approaches and tests innovative approaches for future drought management plans. The running DTP project **DriDanube** (Drought Risk in the Danube Region)[218] contributes to implementing IDMP CEE.

Both DMCSEE and IDMP CEE are focused on a specific climate-related risk (drought). This is also the case for the **coordinated Atlantic Coastal Operational Observatory,** created by the Atlantic Area MyCOAST

[215] http://dmcsee.org

[216] http://www.droughtmanagement.info/idmp-activities/idmp_cee

[217] http://www.droughtmanagement.info

[218] http://www.interreg-danube.eu/approved-projects/dridanube

project[219], and which began in November 2017, to join existing observation capabilities and develop common observing and processing strategies and tools. Target users of the data, services and tools to be provided by the observatory are actors involved in managing and preventing coastal risks such as flooding and coastal erosion, those managing water quality issues, and those responsible for managing maritime safety and response to pollution incidents in the Atlantic area. In addition, observatory data will be used to increase awareness of these risks in the Atlantic Area, and to identify and promote opportunities for the private sector, for instance related to aquaculture, shipping and wind energy providers. Partners of the observatory come from the five countries participating in the INTERREG Atlantic programme (Portugal, Spain, France, United Kingdom and Ireland) and bring experience from existing cross-border cooperation activities, all targeted at the improvement of coastal monitoring and forecasting tools to support threat and emergency response.

[219] http://www.pml.ac.uk/Research/Projects/MyCOAST

Box 4.3: Examples of research-based initiatives supporting climate change adaptation

Although not directly aimed at supporting policy and decision-making in the context of transnational cooperation on CCA and DRR, research-based initiatives (some having a broader scope than climate change) still play an important role in gathering, structuring and sharing research data. This can provide the scientific knowledge basis for platforms and centres specifically aimed at supporting transboundary cooperation on climate change adaptation. A selection of examples for some of the INTERREG cooperation regions are therefore described in this box.

The **European Marine Observation and Data Network (EMODnet)**[220] is a centralised gateway of marine data, products and metadata being assembled by a wide number of local, national, regional and international organisations, which are supported by the EU. **EMODnet** Data Portals provide access to marine data across seven thematic areas: bathymetry, geology, seabed habitats, chemistry, biology, physics and human activities. **EMODnet** also includes six Sea Basin Checkpoints[221] assessing the quality and the utility of the current observation monitoring data at the level of the regional sea-basins (Arctic, Atlantic, Baltic, Black Sea, Med Sea and North Sea). Data are tested against end-user challenges, which are largely common to the six sea basins[222]: wind farm siting, marine protected areas, platform oil leaks, climate change, coastal protection, fishery management and impacts, eutrophication, river input, bathymetry, and alien species or marine environment. Although **EMODnet** has a broader thematic scope, climate change effects on key ocean characteristics (temperature, internal energy, ice coverage, phytoplankton abundance) are included among the challenges of all Sea Basin Checkpoints. Moreover, the coastal protection challenge focuses on sea level variation and sediment balance, although mainly looking at changes that have already occurred.

Baltic Earth[223] aims to promote science-based management in the face of climatic, environmental and human impacts in the Baltic region. It is a focal point for on-going activities of the international research network for this region. Baltic Earth is structured around key research questions (so-called 'grand challenges') and organised in corresponding working groups, which in most cases are also related to climate change aspects: salinity dynamics, land-sea biogeochemical linkages, natural hazards and extreme events, sea level dynamics, regional variability of water and energy exchange, multiple drivers for regional Earth system changes. Baltic Earth plays also an important role in the interaction with Baltic stakeholders and research funding agencies to promote funding for these 'grand challenges'. Among a wide variety of information, it provides access to two 'Assessment of Climate Change for the Baltic Sea Basin (BACC)' reports (BACC Author Team, 2008; BACC II Author Team, 2015), and background material and meeting documents from the working groups.

MedECC[224] is a network of Mediterranean Experts on Climate and environmental Change, which at the end of 2017 involved more than 380 scientists from 31 countries. It was created in 2015 with the main objective of providing science-based support to decision-makers on environmental changes,

[220] http://www.emodnet.eu/

[221] http://www.emodnet.eu/checkpoints

[222] Minor differences characterise the list of sea basin challenges. For example, eutrophication is not included among the challenges of the Arctic checkpoint and bathymetry is not approached by the Mediterranean and North Sea checkpoints. Four checkpoints include alien species among tested challenges (Arctic, Atlantic, Baltic and Black Sea), while the other two deals with marine environment (Mediterranean and North Sea).

[223] https://www.baltic-earth.eu

[224] http://www.medecc.org/

including in particular those related to the climate, affecting the Mediterranean region currently and in the future. The construction of this network responds to several requirements of regional cooperation institutions, such as UNEP/MAP referring to MSSD 2016–2025 and the 'Regional Framework for Climate Change Adaptation in the Mediterranean', as well as the Expert Group on Climate Change of the Union for the Mediterranean. MedECC thematic scope includes all aspects of climate change and biodiversity conservation, embracing the domains of IPCC and also Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). These include the physical and chemical characteristics of the atmosphere and the ocean, all aspects of natural and human systems potentially affected by the changing environment, and economic and social solutions in the form of adaptation and mitigation. MedECC plans to publish its first report on the current state and risks of climate and environmental changes in the Mediterranean by the end of 2019.

The **Virtual Alpine Observatory** (VAO)[225] is a network of Alpine high-altitude research stations that aims to contribute to the monitoring, understanding, and forecasting of processes in the Earth system by aggregating their measurements and performing joint research projects. The participating countries are Austria, France, Germany, Italy, Slovenia, and Switzerland; Georgia and Norway are associated countries. VAO is collaborating with the Alpine Convention and EUSALP.

[225] http://www.vao.bayern.de/index.htm

5 Concluding remarks

KEY MESSAGES:

- Transnational cooperation has usefully supported CCA actions in those European regions faced with transboundary climate change impacts, common challenges, and/or the need to manage shared climate-sensitive resources across borders. It plays a key role in the development and exchange of regionally-specific adaptation knowledge, good practices, and related experiences between countries, regions and stakeholders.
- The INTERREG B programme has played a strong role in promoting transnational cooperation on CCA and DRR in general and in creating the context for project-based collaboration on specific issues. INTERREG B-funded projects have to some extent been successful in facilitating durable adaptation processes, partnerships or initiatives both on transnational and country level. However, the establishment of transnational informal networks of collaboration (e.g. among peer groups of practitioners), which can eventually play a more important role in the long run, is very difficult to track.
- Besides INTERREG B, the above mentioned activities and achievements have also been promoted by EU macro-regional strategies, international conventions and other cooperation initiatives.
- Compared to the previous INTERREG B programming period (2007–2013), more current transnational programmes (2014–2020) have identified CCA/DRR as a cross-cutting/horizontal issue rather than as a stand-alone funding priority or specific thematic objective. This focus on mainstreaming at the programme level has resulted in the drawback that at a project level, CCA tends to get crowded out by other dominant issues. The large majority of projects approved up to June 2018 deal with adaptation at best in an indirect way, as a side issue or as one mainstreaming topic among others. This decline in transnational funding for focused and anticipatory adaptation entails the risk that adaptation efforts in European countries and regions are weakened.
- Achievements of INTERREG B projects most often encompass awareness-raising, joint knowledge generation and knowledge sharing. On the other hand, the knowledge produced in transnational projects only partly succeeds in reaching target groups outside of the project partnership, diffusing into administrative or managerial practices, and penetrating into policy-making fora.
- In a range of countries, INTERREG B projects have also played an enabling role in promoting agenda-setting, exploration and preparation of adaptation policies as well as in promoting front-runner adaptation initiatives in pilot regions and municipalities, building adaptive capacity, and empowering regional and local governments to undertake their own adaptation actions.
- Less often, progress has been made with respect to joint planning and implementation of adaptation actions. Planning and implementation of adaptation on a transnational level appears to have progressed most in contexts where cross-border management of shared resources requires transboundary coordination (e.g. river basins), binding legal frameworks exist (e.g. EU Floods Directive and Water Framework Directive), and responsible and legitimate transnational institutions are in place (e.g., International Commission for the Protection of the Danube River).

- Only in a few European transnational regions (North Sea, Northern Periphery and Arctic, Baltic Sea, Danube, Alpine Space and Mediterranean) common transnational adaptation strategies or action plans are in place. In three cases (Baltic Sea, Alpine Space and Danube), this is likely to have been favoured by the existence of central transnational actors and a pre-existing history of collaboration that has led to the establishment of informal actor networks at different levels (state and non-state actors). Implementation of these transnational strategies remains, however, challenging, as their roles are often not clearly defined, central executive bodies are either missing or lacking legal, political and financial powers for driving implementation, and institutionalised multi-level coordination mechanisms are sometimes weakly developed.
- On the other hand, evidence from two regions (Baltic Sea and Danube) suggests that implementation of transnational adaptation strategies benefits from the following supportive factors: well-developed informal governance mechanisms that mediate between levels and sectors (e.g. BSSR and BSR Climate Dialogue Platform in the Baltic Sea Region); an active lead role and ownership by an established and officially tasked international organisation, especially if it is well aligned with the EU macro-regional strategy process and the INTERREG B programme as provider of funding (e.g. ICPDR, EUSDR and DTP in the Danube region).
- Development of transnational adaptation strategies and/or plans is not necessarily needed. It might be useful if it aims to fill existing gaps between strategies and plans developed at the upper (EU) and lower (national) levels.

5.1 Lessons learned

5.1.1 Cooperation programmes and other policy frameworks for climate change

Climate change adaptation and/or disaster risk reduction in the context of climate change-induced challenges are a distinct priority for few INTERREG V B transnational cooperation programmes 2014–2020 (e.g. North Sea, Atlantic and South West Europe programmes). In most of the transnational regions (e.g. Alpine Space, Central Europe, Danube, North West Europe, Mediterranean, Adriatic-Ionian), climate change adaptation is not defined as a main funding priority or as a specific thematic objective in its own right, but is rather subsumed under broader environmental and risk management themes, or framed as a cross-cutting theme. In several programmes in these regions, CCA has less relevance compared to the preceding INTERREG B period 2007–2013. In these regions, CCA is increasingly conceived as a mainstreaming issue, which often implies that it is indirectly addressed in sector-related projects, such as those related to water management, flood management, management of coastal and marine areas, urban planning, etc. While integrating CCA into projects serving sector policies is desirable from a mainstreaming perspective, this comes with the risk of not granting needed and proper attention to the cross-sectoral and integrated nature of climate change adaptation, as well as of neglecting its long-term time perspective and the need for forward-looking approaches to adaptation. Moreover, the attempt to mainstream adaptation at a programme level seems to have so far not translated into a significant number of projects that are explicitly tackling adaptation needs from a sector perspective. In most of the projects approved so far (June 2018) in the current funding period that focus on sector-specific problems, adaptation often factors merely as a side issue or responses to climate change tend to be rather reactive than anticipatory and transformational. The decrease in transnational support for focused adaptation may result in weakening adaptation action in European regions.

Climate change adaptation is addressed as a target, thematic objective, or action in all four existing EU macro-regional strategies (EUSBSR, EUSAIR, EUSDR, EUSALP). While in EUSALP adaptation is bundled together with (disaster) risk management in one of nine actions, in EUSAIR and EUSBSR adaptation is currently defined as a horizontal principle, relevant to all thematic pillars of both strategies. In the EUSDR, adaptation is addressed mostly in the environmental pillar, and most prominently in the context of flood risk management, management of water scarcity and droughts as well as management of water quality and freshwater ecosystems. Implementation of EU macro-regional strategies is expected to be strategically aligned with the respective INTERREG V B programmes in the same region, and mechanisms are in place to ensure that co-funded projects are in line with the objectives pursued by the action plans of the macro-regional strategies and the actions coherently promoted by the thematic pillars. As a result, a number of projects funded by INTERREG transnational programmes contribute to adaptation-related activities under EU macro-regional strategies. However, the above-mentioned decrease in direct priority of adaptation within the INTERREG transnational programmes may also affect adaptation as a theme within the macro-regional strategies.

The integration of climate change adaptation into conventions and other permanent cooperation policy frameworks has strengthened transnational efforts on CCA in those regions where such cooperation mechanisms exist. This applies in particular to the Alpine Convention and the Carpathian Convention, as prominent examples of treaty-based regimes within transnational regions, which have acted as drivers for a relevant number of projects and cooperation initiatives on climate change adaptation in these regions. Other examples are provided by DRPC, which is home to the 'Climate Adaptation Strategy for the Danube River Basin', the OSPAR Convention, which addresses climate change as a cross-cutting issue, the Barcelona Convention, which in 2016 endorsed the 'Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas' and the HELCOM Convention for the Baltic Sea, which includes climate change within environmental protection and sustainable development goals. These institutionalised cooperation structures are important policy actors at the transnational level that are often acting as facilitators of transnational cooperation on adaptation (EEA, 2014).

In some transnational regions other policy actors, governance bodies or cooperation mechanisms exist that have proven to be beneficial for climate change adaptation at the transnational level. Relevant examples include the Arctic Council (including the Arctic Monitoring and Assessment Programme) in the Northern Periphery and Arctic region, the Trilateral Wadden Sea Cooperation in the North Sea region, CBSS, the transnational network of the national adaptation policymakers of the Alpine countries, which has been established in the frame of the INTERREG Alpine Space project C3-Alps, the Working Community of the Pyrenees, etc.

Enhanced coordination between different transnational cooperation entities can leverage adaptation efforts in transnational regions. In some regions with a long track record of transnational cooperation, adaptation-related issues are covered by two or more transnational policy structures and their related processes. This is the case, for example, of those regions (Baltic, Danube, Alpine Space and Adriatic-Ionian) where conventions co-exist with (usually younger) EU macro-regional strategies that partly address similar thematic fields of activity, which can involve disputes over competences or thematic lead roles. In that respect, a lesson that can be learnt from the case of the Danube region is that collaboration yields better results than competition. Facilitated by the European Commission, the International Commission for the Protection of the Danube River and the EUSDR, which both deal with water management in the Danube basin, have signed a joint cooperation agreement to clarify the roles of both

entities, avoid overlaps and reinforce synergies. Collaboration of both frameworks, which also involves support by the INTERREG Danube Transnational Programme, has since delivered achievements that have increased the capacities for CCA and DRR in the region. The Alpine Convention and EUSALP represent another example of successful collaboration, as they are currently engaged in a similar process of establishing a framework for enhanced mutual cooperation.

5.1.2 Planning for adaptation in transnational regions

Some examples of transnational strategies or action plans on climate change adaptation that bear political relevance (as opposed to mere project-based policy recommendations) exist. One exceptional example is the Strategy for Adaptation to Climate Change in the Baltic Sea Region (Baltadapt Strategy) (Andersson, 2013), which was developed by the Baltadapt project, funded by the INTERREG Baltic Sea Programme 2007–2013. The strategy was integrated into EUSBSR and is accompanied by a non-binding action plan. Another exceptional example is that provided by the Alpine Convention's Action Plan on Climate Change in the Alps (Alpine Convention, 2009), which is based on a political resolution taken by the Alpine Conference of Ministers, although it does not have a legally binding status. Some of the recommendations provided by the Action Plan on Climate Change in the Alps have been taken up by several of the Convention's thematic working bodies in their cyclical work plans. The Alpine Climate Board of the Alpine Convention, established in 2016, is currently working on an Alps-wide Climate Target System for climate-neutral and climate-resilient Alps. Other relevant examples include: the Climate Adaptation Strategy for the Danube River Basin of the International Commission for the Protection of the Danube River (ICPDR, 2012); the Action Plan on Climate Change for the Barents Co-operation adopted in 2013 (BEAC, 2013) and revised in 2017 (BEAC, 2017) and the already mentioned Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas (UNEP/MAP, 2016b) endorsed in the frame of the Barcelona Convention. Although not a strategy in the strict sense of the term, this latter document aims to build a common regional strategic approach to increasing climate resilience and adaptation capacity in the Mediterranean Sea region. These transnational adaptation policy documents are intended to fill a gap in the multi-level governance system between the EU level and the national level, and also reflect the specificities (in terms of vulnerabilities, challenges, policy frameworks, etc.) of the different regions.

Implementation of transnational climate change adaptation strategies might benefit from attachment to existing structures and effective multi-level governance mechanisms. The existing transnational strategies on climate change adaptation, such as the Alpine Convention's Action Plan on Climate Change in the Alps, may partly have fulfilled the functions often attributed to such non-binding policy documents, i.e. to deliver impacts in terms of awareness-raising, communication, capacity-building, and legitimation. However, many of them are struggling with barriers which affect their further development and actual implementation, including for example vaguely defined roles, missing central bodies in charge of coordination across levels and sectors, lacking legal, political and financial powers for driving implementation, and weakly developed multi-level governance mechanisms. On the other hand, some important supportive factors become visible from the analysis of some transnational regions' experiences on cooperation on CCA and DRR. In the Baltic Sea Region, BSR Climate Dialogue platform installed by CBSS acts as an informal transnational governance format for the Strategy for Adaptation to Climate Change in the Baltic Sea Region that intermediates between different levels and sectors, thus compensating to some extent for the lack of institutionalised multi-level coordination at the transnational level. Another lesson to be learnt from the Baltic case may be that more clearly defined roles of transnational adaptation strategies would give transnational actors more leeway (Clar,

forthcoming; Clar and Steurer, 2017). In the Danube region, the successful integration of the Climate Adaptation Strategy for the Danube River Basin into the transnational implementation of the EU Water Framework and Floods Directives (by means of the Danube River Basin Management Plan and the Danube Flood Risk Management Plan) demonstrates further supportive context conditions: (1) firstly, ownership and active lead role by a central, legitimate and officially tasked international organisation (here: ICPDR); (2) secondly, embedding of implementation in a binding framework (EU water legislation); and, thirdly, alignment with the macro-regional strategy process (EUSDR) and the INTERREG V B DTP. A general lesson supported by all cases is that transnational adaptation strategies should attach to existing transnational policy frameworks rather than trying to introduce new governance structures or layers.

Joint planning and implementation of adaptation actions has progressed less, but good examples do exist and indicate possible success factors. Planning and implementation of adaptation at a transnational level occurs considerably less often than the generation and sharing of knowledge. Referring to the example of the Danube region (and specifically to the Danube River Basin and Danube Flood Risk Management plans), the following context conditions appear as favourable factors: (1) the need for cross-border coordination in the management of transboundary resources and related climate change impacts (e.g. river basins); (2) embedding of adaptation concerns in a binding legal framework (e.g. EU Floods Directive and Water Framework Directive); (3) the presence of a legitimate transnational institution that coordinates joint planning activities (e.g. the International Commission for the Protection of the Danube River); and (4) an official mandate entrusted to this institution at a political level (national governments).

5.1.3 Knowledge creation and sharing at transnational level through projects

Typical knowledge outputs of transnational projects include, inter alia, (harmonised) common datasets and inventories, impact monitoring networks, online knowledge infrastructure for sharing information, jointly developed methods and procedures, and studies on specific issues that contribute to enhancement of the knowledge base. Decision-support tools, work aids, guidance documents, practice manuals as well as collections of good practice examples are also commonly produced. In addition, the development of expert-based policy recommendations and transnational strategy papers feature as relevant project outputs.

Transnational projects (including those on climate change adaptation) tend to focus on knowledge generation and dissemination, awareness-raising, capacity-building, networking and cross-country exchange, rather than on concrete implementation of actions on the ground. Generally speaking, for the scope of transnational cooperation and more specifically for the scope of the INTERREG V B programmes, the focus of projects is mostly on soft measures, and not on implementation of specific measures. Despite the production of this consistent know-how, evidence of practical application of the knowledge and products generated by projects (e.g. in policy and decision-making, or also in the identification, design and implementation of specific adaptation measures) is rather limited or at least not disseminated sufficiently. Implementation in practice is regularly left to the post-project phase, and knowledge and innovation is not always well exploited due to a lack of ownership, commitment and clear responsibilities for further use of results which also depends on the end of funding as well as on a lack of durable business and/or capitalisation models. In some cases it may be that knowledge, tools and practices generated by projects are actually traduced in practical application, but related information is not easily accessible.

Transnational cooperation projects have good potential to deliver added value, but it does not always materialise in practice. As suggested by Kelemen et al. (2014), transnational projects can deliver added value through, among others, the following key mechanisms:

- Development of joint solutions, approaches, tools, procedures and other practices for both the management of shared natural resources and assets, and for the development of joint responses to common challenges related to climate change adaptation and disaster risk reduction;
- Addressing (environmental) issues and challenges that do not have transnational impacts but are common to many regions and cities, which allows learning from more experienced partners and sharing of experience and good practices;
- Due to the pooling of resources – especially knowledge, networks and expertise – cooperation among actors can achieve more than if they acted individually through creating critical mass.

However, this potential does often not fully materialise in practice, as also suggested by Kelemen et al. (2014). The actual uptake of project outputs in practice and their broader diffusion to target groups outside of the project partnership could be improved, among others, by optimising the transferability of results, already planning the follow-up process as an integral part of the project life cycle, developing a capitalisation plan for the transfer and actual use of results, and mobilising respective governance structures and required resources.

Transnational projects have often generated knowledge for tackling truly transnational problems. Many projects have addressed problems that have, by their nature, a transnational dimension, such as water and flood risk management of border-crossing rivers or storm surge affecting coastal areas of more than one country belonging to the same sea basin, or other issues with transboundary spill-over effects (e.g. fire risk). Even if these projects have not progressed to the level of direct transnational planning of shared resources, they often provide valuable tools, monitoring systems, harmonised datasets, etc., which constitute an important basis for improved transboundary management of these resources. Nevertheless, practical application of these products is often hampered by the barriers mentioned above.

Compared to projects output mentioned in the above points, comprehensive integrated impact, vulnerability and risk assessments at the transnational level represent a less common knowledge output of cooperation projects. Notable exceptions include a series of assessment reports prepared in the Baltic Sea region (BACC Author Team, 2008; BACC II Author Team, 2015) and in the North Sea region (Quante and Colijn, 2016), the transnational vulnerability assessment of the Pyrenees prepared by the Pyrenean Climate Change Observatory (OPCC and CTP, 2013), or the assessments produced by the three EC-funded projects CARPATCLIM, CARPIVIA and CarpathCC for the Carpathian region (Werners et al., 2014). The network of Mediterranean Experts on Climate and environmental Change (MedECC) has begun work on the creation of a first report on the current state and risks of climate and environmental changes in the Mediterranean, aiming to support policy-making within the frame of the existing regional cooperation mechanisms. The lack of comprehensive assessments at the transnational level may be connected to the recent finalisation of national assessments in many EU Member States as part of their national adaptation policy processes. From the perspective of the individual country, the availability of a knowledge base at the national level may limit the need for (additional) climate risk or vulnerability assessment at the transnational level, and reduce their perceived added value. At the same time, assessments developed at the transnational level might be particularly useful to support policy and

decision-making in those countries which cannot yet rely on a consistent knowledge base at the national level (in particular non-European countries). Such assessments are also essential to provide a coherent understanding of climate change impacts and vulnerability affecting the entire transnational region and to support the design of proper adaptation responses at this scale.

5.1.4 Knowledge platforms and centres

Knowledge creation and sharing at the transnational level is largely 'project-based'. Dissemination and transfer of knowledge created by projects can be significantly enhanced by structured initiatives specifically aimed at providing knowledge support to policy and decision-making at the level of transnational regions. Such initiatives include climate change adaptation platforms, which, when referring to the transnational regions, are very limited in number. The few existing platforms, i.e. CAPA, the Pyrenean Climate Change Observatory, and the Wadden Sea Climate Change Adaptation Information Platform can provide excellent inspiration for other transnational regions. To be really useful and used, it is essential that the contents, structure, functionalities and web design of such platforms are defined so that they match the actual needs of targeted users. Transnational knowledge portals need to be clear about their audience and the added value they seek to deliver in the existing multi-level landscape of adaptation platforms. From this perspective, they should develop links and avoid major overlaps with other platforms developed at the upper (i.e. Climate-ADAPT) and lower scale (national adaptation platforms). Ensuring maintenance and operational continuity is a key challenge especially to project-based climate change adaptation platforms. Linking to existing regional cooperation structures (e.g. EUSALP in the case of CAPA) or inclusion of relevant resources and services in Climate-ADAPT (as in the case of the knowledge base on adaptation developed in the Baltic Sea region) are both feasible pathways.

Relevant support to policy and decision-making is also provided by 'knowledge sharing centres and networks', which among their objectives include sharing of data, information and services, which are directly relevant for the development of climate change adaptation initiatives (strategies, plans, options, measures, etc.) at the transnational and other levels. Very often, these centres and networks are themselves the results of transnational cooperation. Different from climate change adaptation platforms, a wide number of examples of these initiatives can be identified, some of them also initiated through INTERREG-funded projects. Some knowledge centres and networks attempt to deal with the cross-cutting and cross-sector dimension of climate change adaptation, as in the case of the ECRAN, the BSR Climate Dialogue Platform or the Arctic Adaptation Exchange Portal. In other cases, knowledge centres and networks tend to focus on climate change challenges which assume particular relevance in the specific transnational region they deal with, as in the case of the Drought Management Centre for South East Europe (DMCSEE) and IDMP CEE. As in the case of climate change adaptation platforms, it is of key importance that knowledge centres and networks are kept alive and operational beyond the life time of the project that provided initial funding, which also implies that a key actor is assigned responsibility and proper financial support is secured.

5.2 Conclusions

Transnational cooperation has usefully supported climate change adaptation actions in European regions faced with common transboundary climate change impacts and sharing common challenges.

INTERREG B transnational cooperation programmes have played a significant role in: (1) developing the knowledge basis and tools which are needed to support climate change adaptation actions; (2)

improving awareness-raising and capacity building; (3) promoting agenda-setting, inception and exploration of adaptation policies; and (4) piloting climate change adaptation initiatives in many countries. Some of the regions have a broader view on adaptation and tend also to deal with its integrated nature, while in some other regions the focus is mainly on transnational cooperation for adaptation to specific climate change challenges, including those related to DRR. A significant role in supporting climate change adaptation actions is also played by the existing EU macro-regional strategies and international conventions, which in general include climate change adaptation in their policy agendas. In some regions, other cooperation mechanisms with different levels of formalisation and/or specific CCA strategies and plans are active in supporting climate change adaptation at the transnational level. The fact that INTERREG B programmes, EU macro-regional strategies and international conventions are addressing climate change and adaptation in their priorities and objectives demonstrates that policy awareness on the need for adaptation at transnational level is well established in the transnational cooperation structures and their policy documents.

However, climate change adaptation is considered as a distinct priority only in few INTERREG V B 2014- 2020 cooperation programmes.

In the current INTERREG V B programmes climate change adaptation is often considered to be a horizontal issue and compared to the previous funding period (2007–2013) it has lost direct relevance as a main funding priority or specific thematic. In most of the transnational regions (even if not all), adaptation appears to be more and more conceived at a programme level as a mainstreaming issue that is rather indirectly addressed in sectoral projects (e.g. on water management, flood management, fire risk management, etc.). Projects explicitly dedicated to the integration of adaptation into sectors have so far been limited in number, and the real mainstreaming of adaptation on project level remains weak. Further support is thus needed, and increasing the funding priority of adaptation would be beneficial in this regard.

Climate change adaptation is addressed as a target, thematic objective, or action in all four existing EU macro-regional strategies. They overlap with the INTERREG transnational regions do not usually cover the same area.

The EU macro-regional strategies are developed and implemented with the close involvement of national and regional (and sometimes local) governments. Activities under these strategies can therefore be expected to have substantial impacts on policies within the participating countries, also as far as climate change adaptation is concerned. The INTERREG V B programmes in the corresponding transnational regions support the implementation of EU macro-regional strategies by providing funding to specific projects and to the macro-regional governance process. Moreover, the integration of adaptation into international conventions and other cooperation initiatives has strengthened transnational efforts in those regions where such cooperation mechanisms exist. They are policy actors playing a relevant facilitation role for transnational cooperation, as well as on CCA and DRR. Richness in cooperation programmes and policy frameworks (INTERREG programmes, EU macro-macro regional strategies, international conventions, other cooperation initiatives) strongly call for enhanced coordination between the different actors playing a role on CCA and DRR at the transnational level.

Some examples of transnational strategies or action plans on climate change adaptation that bear a political relevance exist.

Although they are limited in number, existing examples of transnational strategies and action plans can be of inspiration to other regions. However, it should be borne in mind that, due to the diversity of transnational regions across Europe, there is no one-size-fits-all approach, and development of transnational policy documents for adaptation is neither a necessary precondition for implementing adaptation actions, nor is it a guarantee of success. They might be beneficial when they actually intend to fill a gap in the multi-level governance system between EU and the national levels. In order to deliver added value and become really effective, transnational adaptation strategies need to meet some requirements and to tackle a number of challenges, such as: weakly developed multi-level governance mechanisms, lack or limited empowerment of coordination arrangements, limited capacity to actually influence policy and decision-making at the national level coherently with strategic orientation taken at the transnational scale, and limited availability of resources. Attachment to existing structures (e.g. EU macro-regional strategies) and reinforcement of existing multi-level governance mechanisms might help in this regard.

Transnational cooperation contributes to the development and exchange of region-specific knowledge between countries and stakeholders. Most transnational projects focus on 'soft actions' and are not expected to directly implement concrete measures on the ground. Evidence of practical application of knowledge and products generated by projects is limited.

In synergy with the scope of transnational cooperation and the objectives of the INTERREG B programmes, in general, transnational projects on climate change adaptation and disaster risk reduction tend to focus on knowledge generation and sharing, awareness raising, capacity-building, networking and cross-country exchange. Typical products and activities on transnational level comprise studies, recommendations, manuals, guidelines, awareness raising campaigns, collection and dissemination of good practice examples, etc. Therefore, the focus of projects is mostly on 'soft actions' rather than on the implementation of specific measures. Implementation in practice is regularly left to the post-project phase, and is hampered by lack of ownership, commitment and clear responsibilities for further use of results, which depends on the end of funding as well as on a lack of durable business and/or capitalisation models. It can nevertheless be stated that the transnational projects have contributed to public and policy awareness of the need for adaptation at national and regional levels. In some cases, practical implementation might even have occurred, but information providing evidence of this can be difficult to access. In any case, it is important that the optimisation of project outcome transferability is planned and organised early in the project, for example developing a capitalisation plan and clearly identifying post-project roles and resources as part of the project life cycle.

In the field of transnational cooperation, 'cluster projects' have been key for empowering stakeholders and expanding networking, which should facilitate the potential implementation of actions.

Cluster projects provide support and facilitate interaction and networking among similar projects running in the same region and/or engaging a wide arena of stakeholders in capitalisation, transfer and user-oriented preparation of project results. Therefore, the main purpose of cluster projects is to improve the communication of project results in order to increase the visibility and capitalisation in specific thematic areas. A key advantage of participating in a cluster project relates to the resulting increase in visibility of the projects and their results at a higher level which, in turn, also raises the awareness of politicians at EU level (INTERREG NSR, 2015b). These projects are consequently expected

to generate lasting impacts that have influence on transnational and national adaptation policies, but this is rarely specifically evaluated.

Knowledge creation and sharing at the transnational level is largely 'project-based'. Dissemination and transfer of knowledge created by projects can be significantly enhanced by structured initiatives (climate change adaptation platforms and knowledge sharing centres and networks) specifically aimed at providing knowledge support to policy and decision-making at the level of transnational regions.

Structured experiences of knowledge sharing at transnational level focused on climate change adaptation and/or disaster risk management are limited in number. Some of them aim to deal with the cross-sector and integrated nature of climate change adaptation, while others tend to focus on the climate change challenges specifically characterised in the regions addressed. For the actual use of both climate change adaptation platforms and knowledge sharing centres and networks a number of issues are particularly relevant: ensuring maintenance and operational continuity; clearly identifying target users and tailoring contents and knowledge transfer pathways to their specific needs; identifying ownership of committed actors with clear responsibilities for financing and managing the knowledge sharing platforms or centres. In any case, these knowledge-sharing initiatives should be linked with existing transnational cooperation mechanisms and actors (principally EU macro-regional strategies and sea or land-based conventions). If this is not possible, another option could be to integrate the materials provided by these platforms, centres and networks in already existing infrastructure at the national and/or European level, including Climate-ADAPT.

Annex 1: EU Overseas Entities

KEY MESSAGES:

- The European Union Outermost Regions are particularly vulnerable to climate change impacts especially from sea level rise and extreme weather and climate events.
- Information on projects funded under the current programming period 2014–2020 was not available at June 2018. Projects undertaken between 2007–2013 largely focused on disaster risk management rather than climate change adaptation.

The EU includes 34 overseas territories linked to six Member States. Nine of them are classified as **Outermost Regions (ORs)** and form an integral part of the EU. They comprise: 3 French overseas departments (Martinique, Guadeloupe and French Guyana) and 1 French overseas community in the Caribbean (Saint-Martin); the French overseas departments of Mayotte and Réunion in the Indian Ocean; two Portuguese autonomous regions (Madeira and the Azores) and one Spanish autonomous community (the Canary Islands) in the Atlantic.

The remaining 25 **Overseas Countries and Territories (OCTs)** enjoy a special 'associate' status and are linked to Denmark, France, the Netherlands and the United Kingdom. These territories are constitutionally linked to the parent Member State, but are not part of the single market and must comply with the obligations on trade imposed on third countries. Council Decision 2013/755/EU details EU's association relations with OCTs.

The ORs and OCTs differ greatly from one another in terms of their autonomy from the parent Member State, and with respect to their socio-economic characteristics. However, they share a number of common features and challenges, including remoteness, the small size of their populations and economies, the limited economic diversification, and the vulnerability to external shocks, including natural disasters and climate change impacts.

The EU Strategy on Adaptation to Climate Change includes ORs among the European regions that are particularly vulnerable to climate change impacts (EC, 2013c). At the same time, these territories show great potential for growth by accounting for over half of the marine Exclusive Economic Zone (EEZ) of the EU and by hosting an extraordinary ecological richness compared to continental Europe (EC, 2012a).

This annex focuses on the transnational cooperation programmes involving ORs in the Caribbean and Indian Oceans, namely: the 'Caribbean Area' (Figure A.1), the 'Indian Ocean Area' (Figure A.2), and the **'**AMAZONIA**'** (Figure A.3) cooperation programmes. The Caribbean Area includes Guadeloupe, French Guiana, Martinique and Saint Martin, and involves as partners around 40 third countries and OCTs in the Caribbean basin. The Indian Ocean Area comprises Réunion and Mayotte and 12 third countries in the southern Indian Ocean (Union of the Comoros, Madagascar, Mauritius, Seychelles, South Africa, Tanzania, Mozambique, Kenya, India, Sri Lanka, Maldives and Australia), as well as the French Southern and Antarctic Lands. Finally, the AMAZONIA programme promotes cooperation among French Guiana, Suriname and the states of Amapá and Amazonas in Brazil. The Portuguese autonomous regions of Madeira and the Azores and the Spanish autonomous community of the Canary Islands, once joined into

the Madeira-Açores-Canarias (MAC) transnational programme 2007–2013, are currently subsumed under the Atlantic Area programme (see section 3.2).

As some OCTs are comprised in the Caribbean Area cooperation programme (Monstserrat and British Virgin Islands for UK, and the Dutch territories of Saint Eustatius, Saba, Aruba, Curaçao and Bonaire) considerations on climate change expected impacts made for Caribbean OR also apply to them.

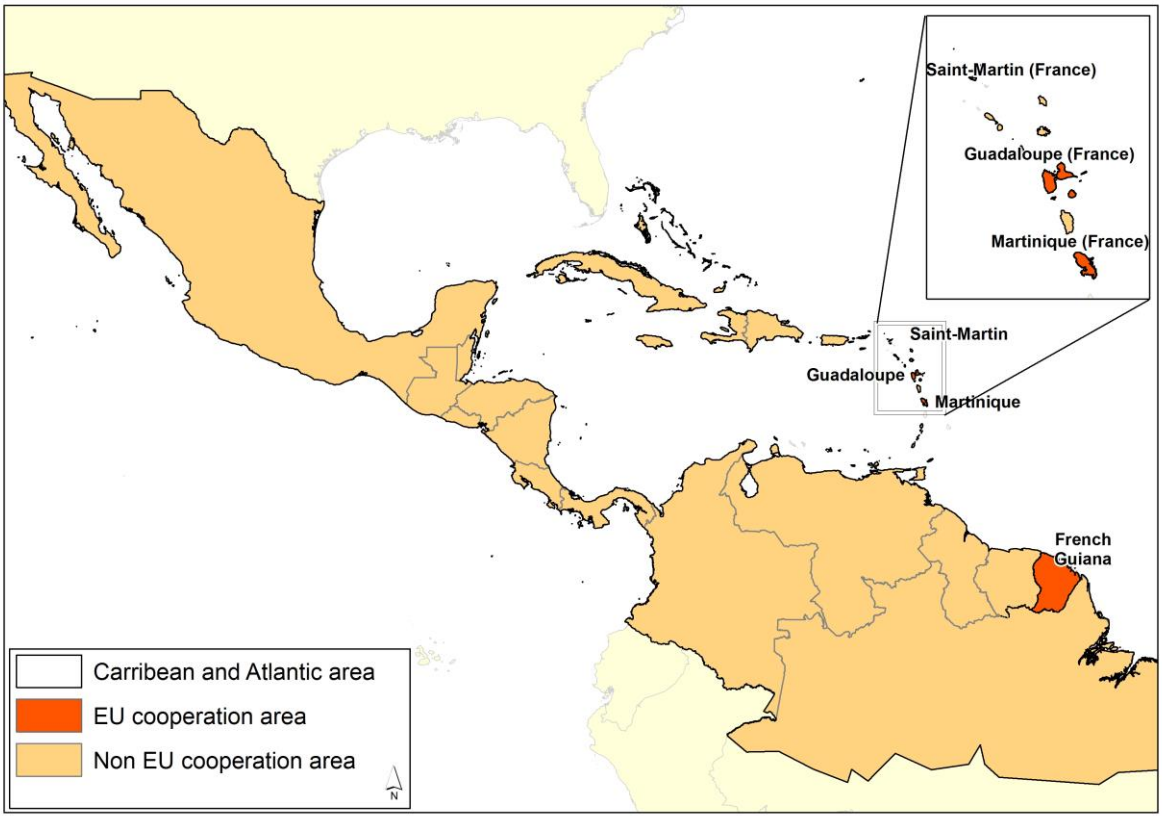


Figure A.1: The Caribbean Area Cooperation programme
(source: ETC/CCA elaboration).

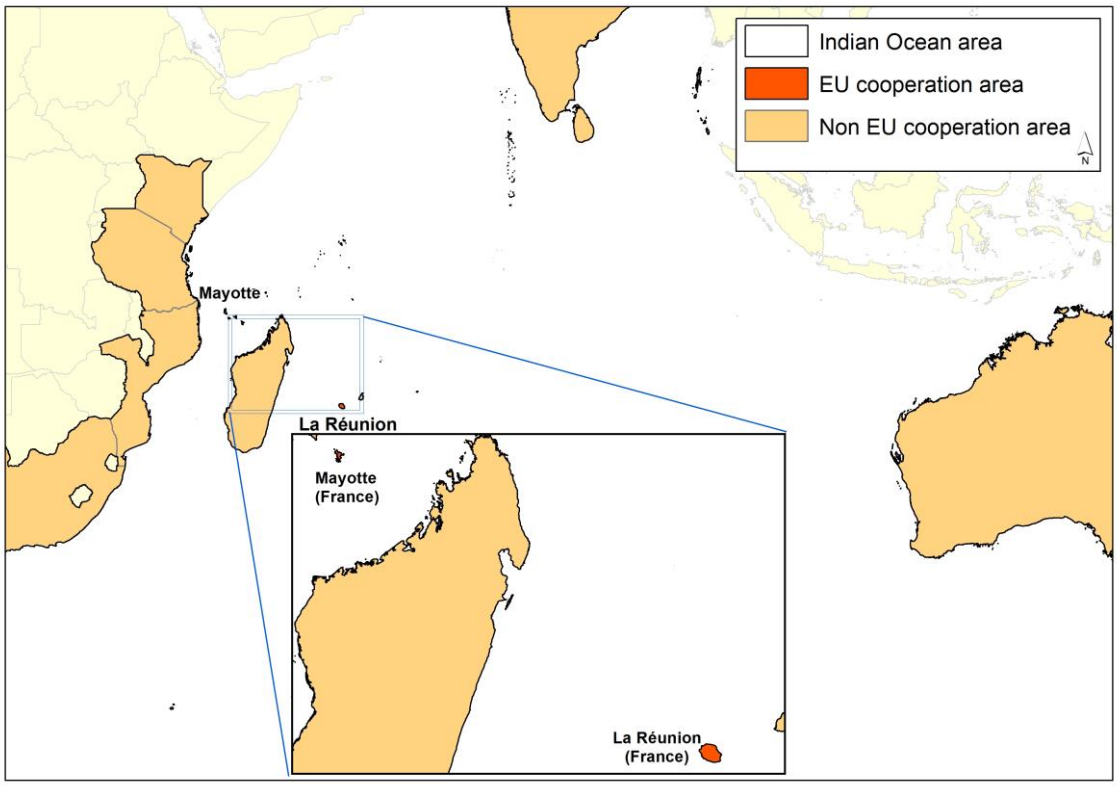


Figure A.2: The Indian Ocean Area cooperation programme
(source: ETC/CCA elaboration).

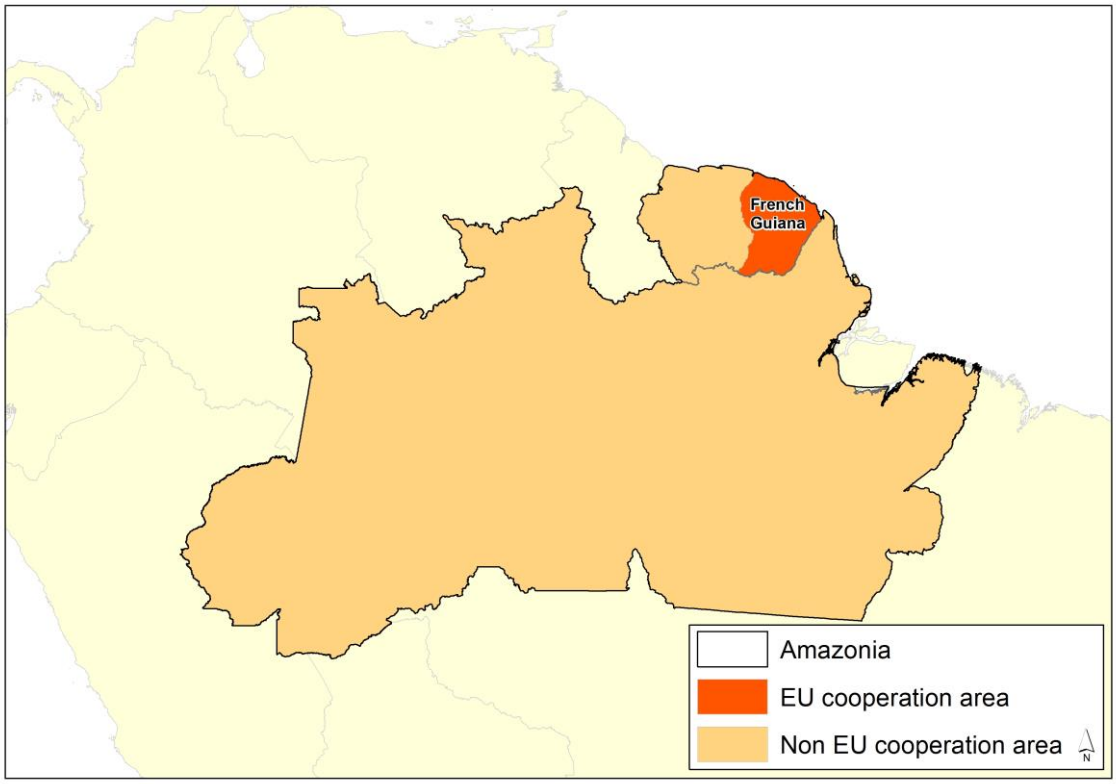


Figure A.3: The AMAZONIA cooperation programme
(source: ETC/CCA elaboration).

Climate change, impacts and vulnerability

As insular, and in many cases, low-lying territories, ORs are on the frontline of climate change impacts. Major current and expected climate-related risks are associated with sea level rise, tropical and extratropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns (Nurse et al., 2014). In particular, air temperature, according to climate projections with the intermediate low RCP4.5 scenario, are expected to increase between 1.2°C and 1.5°C by the end of this century, while precipitation is expected to decrease by about 5% in the Caribbean and increase between 2 and 9% in the Indian Ocean. Changes in rainfall are expected, with different seasonal patterns. Earlier downscaled projections (Campbell et al., 2011) highlighted an increase in precipitation towards the end of the wet season (November–January) in the northern Caribbean and to drier conditions during the traditional wet season (June–October) in the southern Caribbean, increasing drought risk and threatening food production.

Sea level rise in the Caribbean and Indian Oceans is projected to range from 0.5 to 0.6 m by 2100 compared to 1986–2005 for the intermediate low RCP4.5 scenario (Nurse et al., 2014). Together with extreme precipitation and storms, this will lead to severe sea-flood and erosion risks, and to seawater intrusion in freshwater aquifers. Moreover, SLR represents a major potential threat for mangroves (Ward et al., 2016) and the associated ecosystem goods and services (e.g. coastal protection) they provide to local communities. Increasing sea temperature and ocean acidification are expected to lead to increased coral bleaching and reef degradation. These ecosystems provide a number of services to local communities including subsistence fishery and support to tourism, which are expected to experience several impacts (Nurse et al., 2014).

Cooperation programmes and initiatives for adaptation

ORs can combine both cross-border and transnational cooperation actions in a single cooperation programme[226].

The Caribbean Area cooperation Programme 2014–2020[227], launched in December 2016[228], involves Guadeloupe, French Guiana, Martinique and Saint Martin, and around 40 third countries and OCTs in the Caribbean basin. It is run in partnership with the three regional economic organisations, i.e. the Caribbean Community (CARICOM), the Association of Caribbean States (ACS), and the Organisation of Eastern Caribbean States (OECS). In the context of CARICOM, the **Caribbean Community Climate Change Centre (CCCCC)** was established as a reference point for research on climate change impacts and adaptation strategies in the region (see Box A1.1). The programme is structured in two components: (1) cross-border cooperation between Guadeloupe, Martinique and the OECS countries, and (2) transnational cooperation involving Guadeloupe, French Guiana, Martinique and Saint Martin and the other participating countries and territories. It has 6 priority areas aiming to: (1) increase the competitiveness of Caribbean enterprises; (2) increase natural hazard response capacity; (3) protect the cultural and natural environment; (4) respond to shared health issues at Caribbean level; (5) support the development of renewable energies; and (6) strengthen human capital. Priority 2 on disaster risk

[226] http://www.europarl.europa.eu/factsheets/en/sheet/98/support-from-the-european-regional-development-fund-for-european-territorial-coo

[227] http://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/france/2014tc16rftn008

[228] https://www.interreg-caraibes.fr

reduction and management aims to improve knowledge of natural hazards and create shared risk management systems, especially by developing shared observation tools and a geographic information system suitable for crisis management. The previous operational programme 2007–2013 did not include an explicit reference to climate change adaptation or disaster risk reduction. However, Priority 2 'Environment, sustainable management of resources – terrestrial, maritime – and risks' aims to encourage sustainable management policies for natural areas, through the creation of common structures and pilot projects on waste management, water resources, coastal management and biodiversity[229].

The Indian Ocean Area cooperation Programme 2014–2020[230] fosters cooperation between Réunion and Mayotte (France) and 12 third countries in the southern Indian Ocean (Union of the Comoros, Madagascar, Mauritius, Seychelles, South Africa, Tanzania, Mozambique, Kenya, India, Sri Lanka, Maldives and Australia), as well as the French Southern and Antarctic Lands. The programme is built on (1) the cross-border cooperation between Réunion and Comoros, Madagascar, Mauritius and Seychelles as members of the Indian Ocean Commission, and (2) a broader transnational cooperation between Réunion, Mayotte and the other participating countries. The programme has five strategic priorities, two of which are climate change-related. Priority 1 aims to create a research and innovation centre, focusing on pharmacopoeia, biotechnology, energy and climate change. Priority 3 seeks to develop capacities for climate change adaptation and risk prevention and management, by strengthening regional civil protection measures; cooperation on epidemiological and infectious risks; and prevention of risks associated with marine activities. The previous operational programme 2007–2013 did not directly addressed climate change adaptation. However, Priority 1 'Sustainable development and the environment' included strengthening the fight against natural hazards (cyclones, emerging diseases, etc.) among its objectives[231].

The AMAZONIA cooperation Programme 2014–2020[232] promotes cross-border and transnational cooperation among French Guiana, Suriname and the states of Amapá and Amazonas in Brazil. The programme makes no reference to adaptation and risk management in its priority areas. Priority 2 generally deals with environmental conservation and natural resource management. Special emphasis is placed on protecting and enhancing local biodiversity and natural and cultural heritage through joint preservation actions. Priority areas include: (1) improving mobility and transportation in the cooperation area; (2) protecting and enhancing the biodiversity and natural and cultural heritage through joint environmental preservation actions; (3) tackling health and social issues by scientific and health cooperation, particularly on Human Immunodeficiency Virus (HIV) and vector-borne diseases; (4) developing trade in key sectors such as agri-food, renewable energies, information and communication technologies, ecotourism. Also, the previous operational programme 2007–2013 did not include direct or indirect reference to climate change adaptation or disaster risk reduction.

[229] http://ec.europa.eu/regional_policy/en/atlas/programmes/2007–2013/crossborder/operational-programme-caribbean

[230] http://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/france/2014tc16rftn009

[231] http://ec.europa.eu/regional_policy/en/atlas/programmes/2007–2013/crossborder/operational-programme-indian-ocean

[232] http://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/france/2014tc16rftn010

Knowledge creation and sharing at transnational level

Very few projects funded under the previous and current Caribbean Area cooperation programmes aims to develop and share knowledge in support of transnational adaptation efforts. An exception is the '**Caribbean competition pole on natural and sea-related hazards**' project[233], funded under the programming period 2007–2013. The project aimed at strengthening disaster prevention and enhancing early warning systems in small island territories and tropical areas by creating a pole in Martinique to bring together Caribbean experts working on related issues. In fact, most of the projects funded in the 2007–2013 period were operational in nature, and focused on the development of structural and non-structural measures for disaster risk management. For instance, **AUTONOMY 72 HOURS**[234] aims to increase preparedness of families in Guadeloupe against a number of natural disasters, including floods and cyclones. Similarly, the '**Reinforcing response capacity to natural catastrophes in the Caribbean**' project sought to improve water and sanitation practices in the emergency phase as a way to reduce associated public health risks[235]. On a different note, the '**Management plan for the Belle Plaine catchment**'[236] developed both structure and management options, by building a retention pond and protective dikes, creating and/or renewing rainwater collection and drainage networks, and developing a concerted cross-border management policy as well as a common flood warning system. With respect to the current programming period, no information on funded projects is yet available.

As for the Indian Ocean area, the operational programme 2007–2013 provided funding to the regional civil protection mechanism under priority Axis 1 'Sustainable development'. In particular, it supported the French Red Cross in Reunion to develop a Regional Cooperation Programme to manage disaster risk in the South-Western Indian Ocean as well as the subsequent action plan[237].

By to June 2018, there was no information on the projects funded under the current period. It is worth noting, however, that the programme includes the creation of a research and innovation centre focusing *inter alia* on energy and climate change as a specific goal for the period 2014–2020.

[233] https://www.keep.eu/keep/project-ext/21215/Cluster+%28p%C3%B4le+de+comp%C3%A9titivit%C3%A9%29+Caraibe+des+risques+naturels+et+de+la+mer?ss=89179656ba25366567058dc59bbf4474&espon

[234] https://www.keep.eu/keep/project-ext/21208/AUTONOMY+72+HOURS?ss=c4835941393623822be87924f45123b0&espon

[235] https://www.keep.eu/keep/project-ext/41221/Renforcement+des+capacit%C3%A9s+de+r%C3%A9ponses+aux+catastrophes+naturelles+des+territoires+de+la+Cara%C3%AFbe?ss=908e97e71c6671398603c8f8377e762e&espon

[236] https://www.keep.eu/keep/project-ext/41226/Plan+de+gestion+des+inondations+du+bassin+versant+de+Belle+Plaine?ss=908e97e71c6671398603c8f8377e762e&espon

[237] http://www.reunioneurope.org/DOCS/PO_COOP_PROJETS_AIDES_1-03.pdf

Box A1.1: The Caribbean Community Climate Change Centre (CCCCC)

The Caribbean Community Climate Change Centre (CCCCC)[238] represents a reference point for research on climate change impacts and adaptation strategies in the region. The centre opened in 2005 in order to coordinate the region's response to managing and adapting to climate change. It is the official repository and clearinghouse for regional climate change data. The clearinghouse is an online archive and information exchange system helping users to search, access, request and contribute digital documents, project reports and scholarly articles related to climate change in the Caribbean, and view climate projections by country239. The Centre provides climate change-related policy advice to the CARICOM Member States and to UK Caribbean Overseas Territories. It is recognised by the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Environment Programme (UNEP), and other international agencies as the focal point for climate change issues in the Caribbean.

[238] http://www.caribbeanclimate.bz/

[239] http://clearinghouse.caribbeanclimate.bz/?db_type=0&country=&collection=V501&s=&sector=&topic

References

Adloff, F., et al., 2015, 'Mediterranean Sea response to climate change in an ensemble of twenty first century scenarios', *Climate Dynamics* 45(9-10), pp. 2775-2802 (DOI: 10.1007/s00382-015-2507-3).

Alberton, M., et al., 2017, *Outlook on climate change adaptation in the Carpatian mountains*, GRID-Arendal and Eurac Research, Nairobi, Vienna, Arendal and Bolzano.

Alexandris, S., et al., 2012, *Drought Management Centre for South-East Europe – DMCSEE. Summary of projects results.*, Slovenian Environmental Agency.

Alfthan, B., et al., 2015, *Outlook on climate change adaptation in the Western Balkan mountains.*, United Nations Environment Programme, GRID-Arendal and Environmental Innovations Association.

Allenbach, K., et al., 2015, 'Black Sea beaches vulnerability to sea level rise', *Environmental Science & Policy* 46, pp. 95-109 (DOI: 10.1016/j.envsci.2014.07.014).

Alpert, P., et al., 2013,'The Hydrological Cycle of the Mediterranean', in: Navarra, A. and Tubiana, L. (eds), *Regional Assessment of Climate Change in the Mediterranean*, Springer Netherlands, Dordrecht, pp. 201-239.

Alpine Convention, 1995, Alpine Convention - Framework convention.

Alpine Convention, 2006, *Declaration on climate change. (ACIX/07/1)*, Alpine Convention.

Alpine Convention, 2009, *Action Plan on Climate Change in the Alps (ACX/B6).*, AC - Alpine Convention.

Alpine Space 2014–2020, 2015,'Alpine Space - About - which area is covered?' (http://www.alpine-space.eu/about/the-programme/which-area-is-covered-) accessed 31 July 2018.

Altvater, S. and Stuke, F., 2013, *Baltadapt Action Plan: Recommended actions and proposed guidelines for climate change adaptation in the Baltic Sea Region*, Copenhagen: Danish Meteorological Institute.

AMAP, 2011, *Snow, water, ice and permafrost in the Arctic (SWIPA): climate change and the cryosphere*, Arctic Monitoring and Assessment Program (AMAP), Oslo, Norway.

AMAP, 2017a, *Adaptation Actions for a Changing Arctic: Perspectives from the Barents Area*, Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway.

AMAP, 2017b, *Snow, Water, Ice and Permafrost in the Arctic (SWIPA) 2017*, Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway.

Ameztegui, A., et al., 2016, 'Land-use legacies rather than climate change are driving the recent upward shift of the mountain tree line in the Pyrenees: Past human use drives upward tree line shift in the Pyrenees', *Global Ecology and Biogeography* 25(3), pp. 263-273 (DOI: 10.1111/geb.12407).

Anders, I., et al., 2014,'Climate Change in Central and Eastern Europe', in: *Managing Protected Areas in Central and Eastern Europe Under Climate Change*, Advances in Global Change Research, Springer, Dordrecht, pp. 17-30.

Andersson, L., 2013, *Baltadapt Strategy for Adaptation to Climate Change in the Baltic Sea Region: A proposal preparing the ground for political endorsement throughout the Baltic Sea Region*, Danish Meteorological Institute, Copenhagen, Denmark.

Auer, I., et al., 2005, 'A new instrumental precipitation dataset for the greater alpine region for the period 1800–2002', *International Journal of Climatology* 25(2), pp. 139-166 (DOI: 10.1002/joc.1135).

Auer, I., et al., 2007, 'HISTALP — historical instrumental climatological surface time series of the Greater Alpine Region', *International Journal of Climatology* 27(1), pp. 17-46 (DOI: 10.1002/joc.1377).

Auer, I., et al., 2014,'Vergangene Klimaänderung in Österreich', in: *Österreichischer Sachstandsbericht Klimawandel 2014 [Austrian assessment report 2014] (AAR14)*, Verlag der Österreichischen Akademie der Wissenschaften, Vienna, Austria, pp. 227–300.

Avsar, N. B., et al., 2015,'Coastal Risk Analysis of the Black Sea Under the Sea Level Rise', conference paper presented at: From the Wisdom of the Ages to the Challenges of the Modern World, Sofia, Bulgaria, 17 May 2015.

Baatsen, M., et al., 2015, 'Severe autumn storms in future western Europe with a warmer Atlantic Ocean', *Climate Dynamics* 45(3-4), pp. 949-964 (DOI: 10.1007/s00382-014-2329-8).

BACC Author Team, 2008, *Assessment of climate change for the Baltic Sea basin*, Springer, Berlin, Heidelberg.

BACC II Author Team, 2015, *Second Assessment of Climate Change for the Baltic Sea Basin*, Springer International Publishing, Heidelberg; New York, Dordrecht; London.

BAFU, 2012, *Anpassung an den Klimawandel in der Schweiz — Ziele, Herausforderungen und Handlungsfelder*, Bundesamt für Umwelt (BAFU).

BAIC, 2018, *Butlletí Annual d'Indicadors Climàtics 1950-2017*, Meteorological Service of Catalonia.

Ballarin-Denti, A., et al., 2014, *Guidelines for climate change adaptation at the local level in the Alps*, Alpine Convention.

Barcelona Convention, 1995, Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean.

BEAC, 2013, Action plan on climate change for the Barents cooperation.

BEAC, 2017, Action plan on climate change for the Barents cooperation, 2nd edition.

Beaugrand, G., et al., 2002, 'Diversity of calanoid copepods in the North Atlantic and adjacent seas: species associations and biogeography', *Marine Ecology Progress Series* 232, pp. 179-195 (DOI: 10.3354/meps232179).

Beaugrand, G. and Kirby, R. R., 2010, 'Climate, plankton and cod', *Global Change Biology* 16(4), pp. 1268-1280 (DOI: 10.1111/j.1365-2486.2009.02063.x).

Benelux, 2017, *Adpation au changement climatique au sein du Benelux - Klimaatadaptatie in de Benelux*, Secrétairiat Général de l'Union Benelux.

Beniston, M., 2012, 'Is snow in the Alps receding or disappearing?: Is snow in the Alps receding or disappearing?', *Wiley Interdisciplinary Reviews: Climate Change* 3(4), pp. 349-358 (DOI: 10.1002/wcc.179).

Bisselink, B., et al., 2018, *Impact of a changing climate, land use, and water usage on water resources in the Danube river basin. A model simulation study*, EUR - Scientific and Technical Research Reports No EUR 29228 EN, Joint Research Centre.

BMLFUW, 2012, *Die österreichische Strategie zur Anpassung an den Klimawandel. Teil 2 – AKTIONSPLAN. Handlungsempfehlungen für die Umsetzung. Vom Ministerrat am 23. Oktober 2012 beschlossen*, Bundesministerium für Landwirtschaft, Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW).

BMLFUW, 2017, *Die österreichische Strategie zur Anpassung an den Klimawandel. Teil 2 – AKTIONSPLAN. Handlungsempfehlungen für die Umsetzung. Aktualisierte Fassung Jänner 2017. Vom Ministerrat am 22. August 2017 beschlossen*, Bundesministerium für Landwirtschaft, Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW).

BMUB, et al., 2012, *Danube Study - Climate Change Adaptation. "Study to provide a common and basin-wide understanding towards the development of a Climate Change adaptation strategy in the Danube River Basin"*,

BMUB - German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety; LMU – Ludwig Maximilians Universität München; ICPDR - International Commission for the Protection of the Danube River.

Boisvert, L. N. and Stroeve, J. C., 2015, 'The Arctic is becoming warmer and wetter as revealed by the Atmospheric Infrared Sounder: ATMOSPHERIC INFRARED SOUNDER REVEALS A WARMER AND WETTER ARCTIC', *Geophysical Research Letters* 42(11), pp. 4439-4446 (DOI: 10.1002/2015GL063775).

Bologna Charter, 2014, Joint Action Plan on Med coasts adaptation to Climate change. Developing conditions fo the Blue Growth in the Mediterranean, (http://www.bolognacharter.eu/wp-content/uploads/2016/05/20150206_JAP_BC_COASTGAP_lr.pdf).

Bouttes, N., et al., 2014, 'The drivers of projected North Atlantic sea level change', *Climate Dynamics* 43(5-6), pp. 1531-1544 (DOI: 10.1007/s00382-013-1973-8).

Branković, Č., et al., 2013, 'Evaluating climate change at the Croatian Adriatic from observations and regional climate models' simulations', *Climate Dynamics* 41(9-10), pp. 2353-2373 (DOI: 10.1007/s00382-012-1646-z).

Bulkeley, H., et al., 2012, 'Governing climate change transnationally: assessing the evidence from a database of sixty initiatives', *Environment and Planning C: Government and Policy* 30(4), pp. 591-612 (DOI: 10.1068/c11126).

Bulkeley, H. and Jordan, A., 2012, 'Transnational environmental governance: new findings and emerging research agendas', *Environment and Planning C: Government and Policy* 30(4), pp. 556-570 (DOI: 10.1068/c3004ed).

Camarero, L. and Catalan, J., 2012, 'Atmospheric phosphorus deposition may cause lakes to revert from phosphorus limitation back to nitrogen limitation', *Nature Communications* 3, p. 1118.

Campbell, J. D., et al., 2011, 'Future climate of the Caribbean from a regional climate model', *International Journal of Climatology* 31(12), pp. 1866-1878 (DOI: 10.1002/joc.2200).

Carpathian Convention, 2003, Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention).

Carpathian Convention, 2011, Protocol on Sustainable Forest Management to the Framework Convention on the Protection and sustainable Development of the Carpathians.

CBSS, 2014, Decision by the Council of the Baltic Sea States on a review of the CBSS long term priorities, (http://www.cbss.org/wp-content/uploads/2012/11/Decision-by-the-Council-of-the-Baltic-Sea-States-on-a-review-of-the-CBSS-long-term-priorities.pdf), Council of the Baltic Sea States.

Chenoweth, J., et al., 2011, 'Impact of climate change on the water resources of the eastern Mediterranean and Middle East region: Modeled 21st century changes and implications: IMPACT OF CLIMATE CHANGE ON WATER RESOURCES', *Water Resources Research* 47(6) (DOI: 10.1029/2010WR010269).

Christensen, J. H. and Christensen, O. B., 2007, 'A summary of the PRUDENCE model projections of changes in European climate by the end of this century', *Climatic Change 2007-3-17* 81(S1), pp. 7-30 (DOI: 10.1007/s10584-006-9210-7).

Church, J. A., et al., 2013,'Sea-level change', in: Stocker, T. F. et al. (eds), *Climate change 2013: the physical science basis: contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.

Clar, C., forthcoming, 'The Multi-level governance of climate change adaptation: Are adaptation strategies an adequate coordination tool?', *Environmental Politics*.

Clar, C. and Steurer, R., 2017, *Climate change adaptation at different levels of government: conditions for policy change*, Institute of Forest, Environmental, and Natural Resource Policy (InFER) and Universität für Bodenkultur Wien (BOKU.

Collins, M., et al., 2013,'Long-term climate change: projections, commitments and irreversibility', in: Stocker, T. F. et al. (eds), *Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge; New York, pp. 1029-1136.

Commission on the Protection of the Black Sea Against Pollution, 1994, Bucharest Convention Convention on the Protection of the Black Sea Against Pollution.

COWI, 2017, *Mainstreaming of Adaptation into the ESIF 2014 - 2020*, FINAL REPORT, EC DG Clima.

CPMR, 2017, *Review of EU strategy on adaptation to climate change. (Approved by the CPMR General Assembly, 19-20 October 2017, Helsinki-Finland)*, Policy Position, Conference of Peripheral Maritime Regions (CPMR).

CPMR North Sea Commission, 2016, *North Sea Region 2020. North Sea Commission Strategy - contibuting to the Europe 2020.*, North Sea Commission of the Conference of Peripherical Maritime Regions, (CPMR North Sea).

Cropper, T. E. and Hanna, E., 2014, 'An analysis of the climate of Macaronesia, 1865-2012: THE CLIMATE OF MACARONESIA, 1865-2012', *International Journal of Climatology* 34(3), pp. 604-622 (DOI: 10.1002/joc.3710).

Das, T., et al., 2017, 'Climate change impacts on plant diseases', *SAARC Journal of Agriculture* 14(2), p. 200 (DOI: 10.3329/sja.v14i2.31259).

de Rigo, D., et al., 2017, *Forest fire danger extremes in Europe under climate change: variability and uncertainty*, JRC Technical Reports No EUR 28926 EN, Publications Office of the European Union.

Debernard, J. B. and Røed, L. P., 2008, 'Future wind, wave and storm surge climate in the Northern Seas: a revisit', *Tellus A* 60(3), pp. 427-438 (DOI: 10.1111/j.1600-0870.2008.00312.x).

Déqué, M., et al., 2007, 'An intercomparison of regional climate simulations for Europe: assessing uncertainties in model projections', *Climatic Change* 81(S1), pp. 53-70 (DOI: 10.1007/s10584-006-9228-x).

Dis, A. T., et al., 2010, *Background Paper on Climate Change*, Baltic 21/Council of Baltic Sea States/EU European Regional Development Fund.

Donat, M. G., et al., 2013, 'Updated analyses of temperature and precipitation extreme indices since the beginning of the twentieth century: The HadEX2 dataset: Hadex2-Global Gridded Climate Extremes', *Journal of Geophysical Research: Atmospheres* 118(5), pp. 2098-2118 (DOI: 10.1002/jgrd.50150).

Dumont, B., et al., 2015, 'A meta-analysis of climate change effects on forage quality in grasslands: specificities of mountain and Mediterranean areas', *Grass and Forage Science* 70(2), pp. 239-254 (DOI: 10.1111/gfs.12169).

Dzebo, A. and Stripple, J., 2015, 'Transnational adaptation governance: An emerging fourth era of adaptation', *Global Environmental Change* 35, pp. 423-435 (DOI: 10.1016/j.gloenvcha.2015.10.006).

EC, 2009, Commission Staff Working Document Accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions concerning the European Union Strategy for the Baltic Sea Region - Action Plan (SEC (2009) 712/2).

EC, 2010a, Action Plan accompanying document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. European Union Strategy for the Danube Region (SEC(2010) 1489 final).

EC, 2010b, *Commission Staff Working Document: Action Plan Accompanying the Document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee of the Regions Concerning the European Union Strategy for the Danube Region*, No SWD(2010) 1489 final.

EC, 2010c, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — European Union strategy for Danube region (COM (2010) 715 final of 8 December 2010).

EC, 2011a, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — . Developing a maritime strategy for the Atlantic ocean area (COM(2011) 782 final).

EC, 2011b, *European Territorial Cooperation. building bridges between people*, European Commission DG REgio, Luxembourg, Publications Office of the European Union.

EC, 2012a, Communication from the Commission — The outermost regions of the European Union: towards a partnership for smart, sustainable and inclusive growth (COM(2012) 287 final, 20.06.2012).

EC, 2012b, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions concerning the European Union Strategy for the Baltic Sea Region (COM(2012) 128 final).

EC, 2013a, Action Plan for a Maritime Strategy in the Atlantic area Delivering smart, sustainable and inclusive growth (COM(2013) 279 final).

EC, 2013b, *Commission staff Working Document: Technical guidance on integrating climate change adaptation in programmes and investments of Cohesion Policy, Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An EU Strategy on Adaptation to Climate Change*, No SWD(2013) 135 final.

EC, 2013c, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — An EU Strategy on adaptation to climate change (COM(2013) 216 final).

EC, 2014a, *Commission Staff Working Document: A Sustainable Blue Growth Agenda for the Baltic Sea Region*, No SWD(2014) 167 final.

EC, 2014b, *Commission staff working Document: Action Plan Accompanying the Document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions concerning the European Union Strategy for the Adriatic and Ionian Region.*, No SWD(2014) 190 final.

EC, 2014c, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, concerning the European Union Strategy for the Adriatic and Ionian Region (COM(2014) 357 final).

EC, 2014d, *The economic impact of climate change and adaptation in the Outermost Regions*, Final Report.

EC, 2015a, *Commission Staff Working Document: Action Plan Accompanying the Document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee of the Regions Concerning the European Union Strategy for the Alpine Region*, No SWD(2015) 147 final.

EC, 2015b, Communication from The Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions concerning a European Union Strategy for the Alpine Region (COM/2015/0366 final).

EC, 2016, *Commission Staff Working Document: Accompanying the Document Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Implementation of Eu Macro-Regional Strategies {com(2016) 805 Final}*, No SWD(2016) 443 final.

EC, 2017, *Study on Macroregional Strategies and their links with Cohesion policy - Data and analytical report for the EUSAIR*, EC, DG for Regional and Urban Policy.

EC, 2018a,'ESIF 2014-2020 Finances Planned Details | Data | European Structural and Investment Funds', Socrata (https://cohesiondata.ec.europa.eu/EU-Level/ESIF-2014-2020-FINANCES-PLANNED-DETAILS/e4v6-qrrq/data) accessed 1 August 2018.

EC, 2018b, Evaluation of the EU Strategy on Adaptation to Climate Change – Public consultation meeting: report, (https://ec.europa.eu/clima/sites/clima/files/events/docs/0119/2018_01_23_report_en.pdf) accessed 26 July 2018.

EC, 2018c,'Outline Presentation':, presentation given at: Evaluation of the EU strategy on adaptation to climate change Public consultation meeting, Brussels, Belgium, 23 January 2018.

EC, 2018d, *Report from the Commission to the European Parliament and the Council on the implementation of the EU Strategy on adaptation to climate change.*, No COM(2018) 738 final, European Commission.

EC, 2018e, *Towards an initiative for the sustainable development of the blue economy in the western Mediterranean. Goals & priorities 2015-2020*, European Union 2017, Madrid.

ECRAN, 2016, *ECRAN environment and Climate. Regional Accession Network*, ECRAN environment and Climate. Regional Accession Network.

ECRAN, 2017, *Working together towards alignment with the European Union environmental and climate policies and legislation in EU Candidate Countries and Potential Candidates*, ECRAN environment and Climate. Regional Accession Network.

Edwards, M. and Richardson, A. J., 2004, 'Impact of climate change on marine pelagic phenology and trophic mismatch', *Nature* 430(7002), pp. 881-884 (DOI: 10.1038/nature02808).

EEA, 2002, *Europe's biodiversity - biogeographical regions and seas*, EEA Report No 1/2002, European Environment Agency (EEA).

EEA, 2014, *National adaptation policy processes in European countries — 2014*, EEA Report No 4/2014, European Environment Agency.

EEA, 2015, *Overview of climate change adaptation platforms in Europe*, Technical report No 5/2015, EEA.

EEA, 2017a, *Climate change adaptation and disaster risk reduction in Europe: Enhancing coherence of the knowledge base, policies and practices*, EEA Report No 15/2017, European Environment Agency.

EEA, 2017b, *Climate change, impacts and vulnerability in Europe 2016 — an indicator-based report*, EEA Report No 1/2017, European Environment Agency.

EEA, 2018a, Climate Adapt profile, (https://climate-adapt.eea.europa.eu/about/climate-adapt-profile-final_1.pdf).

EEA, 2018b, *Sharing adaptation information across Europe*, EEA Report No 3/2018, European Environment Agency.

Engelhard, G. H., et al., 2011, 'Ecotypes as a concept for exploring responses to climate change in fish assemblages', *ICES Journal of Marine Science* 68(3), pp. 580-591 (DOI: 10.1093/icesjms/fsq183).

ERDF, 2014, *Northern Periphery Programme 2007–2013. Achievements*, European Regional Development Fund.

ESPON, 2013, *ESPON Evidence Report. North West Europe*,.

EU, 2000, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for community action in the field of water policy (EC 2000/60/EC).

EU, 2007, Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (OJ L 288, 6.11.2007, p. 27-34).

EU, 2010, Council Decision of 13 September 2010 concerning the conclusion, on behalf of the European Union, of the Protocol on Integrated Coastal Zone Management in the Mediterranean to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (2010/631/EU).

EU, 2012, Consolidated Version of the Treaty on the Functioning of the European Union (TFEU) (2012/C 326/01).

EU, 2013a, Regulation (EU) No. 1299/2013 of the European Parliament and of the Council of 17 December 2013 on specific provisions for the support from the European Regional Development Fund to the European territorial cooperation goal (CELEX 347/25).

EU, 2013b, Regulation (EU) No 1301/2013 of the European Parliament and of the Council of 17 December 2013 on the European Regional Development Fund and on specific provisions concerning the Investment for growth and jobs goal and repealing Regulation (EC) No 1080/2006 (1301/2013).

EU, 2013c, Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006 (1303/2013).

EU, 2014a, EU Maritime Security Strategy Action Plan (15658/14).

EU, 2014b, European Union Maritime Security Strategy (11205/14).

EuroGeographics, 2015, Nomenclature of Territorial Units for Statistics (NUTS) 2013 - Statistical Units - Data set, (http://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/nuts#nuts13), European Commission, Eurostat (ESTAT), GISCO; EuroGeographics for the administrative boundaries.

European Court of Auditors, 2016, *Spending at least one euro in every five from the EU budget on climate action: ambitious work underway, but at serious risk of falling short*, Special report No 31/2016, European Court of Auditors.

European Territorial Co-operation, 2013, *South East Europe (SEE). Transnational Co-operation Programme for a European area in transition on the way to integration Operational Programme.*, Modified version Endorsed by the European Commission 28 November 2013.

EUSDR and ICPDR, 2014, *Joint Paper on Cooperation ad synergy for the EUSDR Implementation*,.

Feser, F., et al., 2015, 'Storminess over the North Atlantic and Northwestern Europe — A review', *Quarterly Journal of the Royal Meteorological Society* 141(687), pp. 350-382 (DOI: 10.1002/qj.2364).

Fischer, E. M. and Schär, C., 2010, 'Consistent geographical patterns of changes in high-impact European heatwaves', *Nature Geoscience* 3(6), pp. 398-403 (DOI: 10.1038/ngeo866).

Gänzle, S. and Kern, K., 2011,'Macro-regional Strategies: A New Mode of Differentiated Integration in the European Union', conference paper presented at: CEPSA Annual Conference, Vienna, Austria, 27 October 2011.

García-González, R., et al., 2016, 'Factors Affecting Diet Variation in the Pyrenean Rock Ptarmigan (Lagopus muta pyrenaica): Conservation Implications' Lutermann, H. (ed.), *PLOS ONE* 11(2), p. e0148614 (DOI: 10.1371/journal.pone.0148614).

Gaslikova, L., et al., 2011, 'Future storm surge impacts on insurable losses for the North Sea region', *Natural Hazards and Earth System Science* 11(4), pp. 1205-1216 (DOI: 10.5194/nhess-11-1205-2011).

Giorgi, F., et al., 2004, 'Mean, interannual variability and trends in a regional climate change experiment over Europe. II: climate change scenarios (2071?2100)', *Climate Dynamics* 23(7-8), pp. 839-858 (DOI: 10.1007/s00382-004-0467-0).

Giorgi, F., 2006, 'Climate change hot-spots', *Geophysical Research Letters* 33(8), p. L08707 (DOI: 10.1029/2006GL025734).

Giorgi, F. and Lionello, P., 2008, 'Climate change projections for the Mediterranean region', *Global and Planetary Change* 63(2–3), pp. 90-104 (DOI: 10.1016/j.gloplacha.2007.09.005).

Glaas, E. and Juhola, S., 2013, 'New Levels of Climate Adaptation Policy: Analyzing the Institutional Interplay in the Baltic Sea Region', *Sustainability* 5(1), pp. 256-275 (DOI: 10.3390/su5010256).

Glibert, P. M., et al., 2014, 'Vulnerability of coastal ecosystems to changes in harmful algal bloom distribution in response to climate change: projections based on model analysis', *Global Change Biology* 20(12), pp. 3845-3858 (DOI: 10.1111/gcb.12662).

Gløersen, E., et al., 2012, *GEOSPECS – Geographic specificities and development potentials in Europe: European Perspective on Specific Types of Territories*, Final Scientific Report. ESPON & University of Geneva No Applied Research 2013/1/12.

Gløersen, E., et al., 2016, 'Quelle base factuelle pour une stratégie européenne de développement durable dans les régions de montagne ?', *Revue de géographie alpine* (104-3) (DOI: 10.4000/rga.3323).

Gobiet, A., et al., 2014, '21st century climate change in the European Alps — A review', *Science of The Total Environment* 493, pp. 1138-1151 (DOI: 10.1016/j.scitotenv.2013.07.050).

Gonzales, M., 2017,'Climate Change and Risks Network', presentation given at: Joint meeting of macro-regional coordinators on climate and disaster risk reduction, Budapest, Hungary, 17 November 2017.

Grabemann, I., et al., 2015, 'Climate change impact on North Sea wave conditions: a consistent analysis of ten projections', *Ocean Dynamics* 65(2), pp. 255-267 (DOI: 10.1007/s10236-014-0800-z).

Grabemann, I. and Weisse, R., 2008, 'Climate change impact on extreme wave conditions in the North Sea: an ensemble study', *Ocean Dynamics* 58(3-4), pp. 199-212 (DOI: 10.1007/s10236-008-0141-x).

Gray, S. R. J., et al., 2014, 'Are coastal managers detecting the problem? Assessing stakeholder perception of climate vulnerability using Fuzzy Cognitive Mapping', *Ocean & Coastal Management* 94, pp. 74-89 (DOI: 10.1016/j.ocecoaman.2013.11.008).

Gualdi, S., et al., 2013a,'Future Climate Projections', in: Navarra, A. and Tubiana, L. (eds), *Regional Assessment of Climate Change in the Mediterranean*, Springer Netherlands, Dordrecht, pp. 53-118.

Gualdi, S., et al., 2013b, 'The CIRCE simulations: regional climate change projections with realistic representation of the Mediterranean Sea', *Bulletin of the American Meteorological Society* 94(1), pp. 65-81 (DOI: 10.1175/BAMS-D-11-00136.1).

Haapala, J. J., et al., 2015,'Recent change — Sea ice', in: The BACC II Author Team (ed.), *Second assessment of climate change for the Baltic Sea basin*, Springer International Publishing, Cham, Switzerland, pp. 145-153.

Halsnaes, K., et al., 2016,'Socio-economic Impacts—Offshore Activities/Energy', in: *North Sea Region Climate Change Assessment*, Springer, pp. 409–415.

Hassoun, A. E. R., et al., 2015, 'Acidification of the Mediterranean Sea from anthropogenic carbon penetration', *Deep Sea Research Part I: Oceanographic Research Papers* 102, pp. 1-15 (DOI: 10.1016/j.dsr.2015.04.005).

Heinrich, G., et al., 2013, *Expected Climate Change and its Uncertainty in the Alpine Region - Extended Uncertainty Assessment of the reclip:century and ENSEMBLES Multi-Model Dataset*, No Scientifc Report No. 50-2013, Wegener Center for Climate and Global Change, University of Graz.

Heinrich, G. and Gobiet, A., 2012, 'The future of dry and wet spells in Europe: a comprehensive study based on the ENSEMBLES regional climate models', *International Journal of Climatology* 32(13), pp. 1951-1970 (DOI: 10.1002/joc.2421).

HELCOM, 1992, Convention on the Protection of the Marine Environment of the Baltic Sea Area, (Helsinki Convention).

HELCOM, 2013, *Climate change in the Baltic Sea Area — HELCOM thematic assessment in 2013*, Baltic Sea Environment Proceedings No 137, Helsinki Commission — Baltic Marine Environment Protection Commission.

Hlásny, T., et al., 2011a, 'Climate change impacts on growth and carbon -balance of forests in Central Europe', *Climate Research* 47(3), pp. 219-236 (DOI: 10.3354/cr01024).

Hlásny, T., et al., 2011b, 'Expected impacts of climate change on forests: Czech Republic as a case study', *Journal of Forest Science* 57(10), pp. 422-431 (DOI: 10.17221/103/2010-JFS).

Hlásny, T. and Turčáni, M., 2009,'Insect pests as climate change driven disturbances in forest ecosystems', in: Střelcová, K. et al. (eds), *Bioclimatology and natural hazards*, Springer Netherlands, Dordrecht, the Netherlands, pp. 165-177.

Hooghe, L. and Keating, M., 1994, 'The politics of European union regional policy', *Journal of European Public Policy* 1(3), pp. 367-393 (DOI: 10.1080/13501769408406965).

Huss, M., 2012, 'Extrapolating glacier mass balance to the mountain-range scale: the European Alps 1900–2100', *The Cryosphere* 6(4), pp. 713-727 (DOI: 10.5194/tc-6-713-2012).

Huthnance, J., et al., 2016,'Recent Change—North Sea', in: Quante, M. and Colijn, F. (eds), *North Sea Region Climate Change Assessment*, Springer International Publishing, Cham, pp. 85-136.

ICES, 2014, *Final Report to OSPAR of the Joint OSPAR/ICES Ocean Acidification Study Group (SGOA)*, No ICES CM 2014/ACOM:67, International Council for the Exploration of the Sea (ICES).

ICPDR, 1994, Convention on cooperation for the protection and sustainable use of the Danube river (Danube Convention). Signed in 1994 in Sofia and in force since 1998.

ICPDR, 2009, *The Danube River Basin District Management Plan*, International Commission for the Protection of the Danube River (ICPDR).

ICPDR, 2010, *Danube Declaration: Danube Basin: Shared waters - joint responsibilities; adopted at the ICPDR Ministerial Meeting, February 16, 2010.*, International Commission for the Protection of the Danube River (ICPDR).

ICPDR, 2012, *ICPDR Strategy on Adaptation to Climate Change*, International Commission for the Protection of the Danube River (ICPDR).

ICPDR, 2013, Strategy on adaptation to climate change, (https://www.icpdr.org/main/sites/default/files/nodes/documents/icpdr_climate-adaptation-strategy.pdf), International Commission for the Protection of the Daube River.

ICPDR, 2015a, *Flood Risk Management Plan for the Danube River Basin District*, International Commission for the Protection of the Danube River (ICPDR).

ICPDR, 2015b, *The Danube River Basin District Management Plan. Update 2015*, International Commission for the Protection of the Danube River (ICPDR).

ICPDR, 2016, *Danube Declaration, adopted at the ICPDR Ministerial Meeting, 9 February 2016.*, International Commission for the Protection of the Danube River (ICPDR).

IMPACT2C project, 2015, *IMPACT2C project — final report*,.

INTERACT Programme, 2017, *Joint meeting of macro-regional coordinators on climate and disaster risk reduction 16-17 November 2017 Budapest, Hungary Report*, INTERACT.

INTERREG ADRION, 2015, *Interreg V-B ADRIATIC-IONIAN COOPERATION PROGRAMME 2014-2020*, INTERREG Adriatic Ionian (ADRION) Programme.

INTERREG ASP, 2007, *Operational Programme Alpine Space. European Territorial Cooperation 2007 - 2013.*, ASP - INTERREG Alpine Space.

INTERREG ASP, 2014, *Interreg Alpine Space. Cooperation Programme. Approved by the European Commission on 17 December 2014*, ASP - INTERREG Alpine Space.

INTERREG Atlantic Area, 2018, *Atlantic Area Programme 2014-2020. Approved Cooperation Programme. Revised version approved by the European Commission on the 27 March 2018*,.

INTERREG Balkan Mediterranean, 2017, *Balkan Mediterranean Cooperation Programme. revised version feb. 2017*, INTERREG Balkan Mediterranean Programme.

INTERREG BSR, 2012, *Baltic Sea Region Cooperation Programme 2007 - 2014. Final approved version 3.0 as of 05 January 2012*,.

INTERREG BSR, 2015, *Baltic Sea Region Cooperation Programme 2014 - 2020.*, INTERREG Baltic Sea Region (BSR).

INTERREG Central Europe, 2007, *Central Europe Cooperation Programme. cooperating for Success. Operational Programme. European Territorial Cooperation 2007-2013*, INTERREG Central Europe (CE) Programme.

INTERREG Central Europe, 2016, *Central Europe Cooperation Programme. European Territorial Cooperation 2014-2020*, INTERREG Central Europe (CE) Programme.

INTERREG Danube, 2017, *Danube Transnational Programme. Version 3*, INTERREG Danube Transnational Programme.

INTERREG Mediterranean, 2016, *Mediterranean (Med) Cooperation Programme 2014-2020. Modified version approved by the European Commission, November 9th 2016*, INTERREG MEditerranean Programme.

INTERREG NPA, 2016, *Northern Periphery and Arctic Cooperation Programme 2014 - 2020. Approved by the European Commission on 16th December 2014, updated in January 2016*, INTERREG Northern Periphery and Arctic Programme (NPA).

INTERREG NSR, 2008, *North Sea Region Cooperation Programme 2007 - 2013*, Interreg North Sea Region (NSR) Programme.

INTERREG NSR, 2015a, *North Sea Region Cooperation Programme 2014 - 2020*, Interreg North Sea Region (NSR) Programme.

INTERREG NSR, 2015b, *North Sea Region Programme Papers No. 12. Executive Summary*, INTERREG North Sea Region (NSR) Programme.

INTERREG NWE, 2015, *Cooperation Programme Interreg North-West Europe 2014 - 2020 Approved by the European Commission on 18 June 2015*, INTEREG North - West Europe.

INTERREG SUDOE, 2017, *Cooperation Programme INTERREG Vb Southwest Europe Adopted by EC 15/02/2017*,.

IPADRATIC CBC, 2013, *IPA Adriatic Cross-Border Cooperation Programme*, amended version 2013.

IPCC, 2007, *Climate change 2007: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007*, Cambridge University Press, Cambridge.

IPCC, 2014, *Climate change 2014: impacts, adaptation and vulnerability — part B: regional aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge; New York.

Jacob, D., et al., 2013, 'EURO-CORDEX: new high-resolution climate change projections for European impact research', *Regional Environmental Change* 14(2), pp. 563-578 (DOI: 10.1007/s10113-013-0499-2).

Johansson, M. M., et al., 2014, 'Global sea level rise scenarios adapted to the Finnish coast', *Journal of Marine Systems* 129, pp. 35-46 (DOI: 10.1016/j.jmarsys.2012.08.007).

JPI Climate, 2016, *Strategic Research and Innovation Agenda*, Joint Programming Initiative Connecting Climate Knowledge for Europe (JPI).

Katsarova, I., 2012, *EU macro-regional strategies: state of play*, Library Briefing: Library of the European Parliament No 120265REV1, European Union.

Keenan, T., et al., 2011, 'Predicting the future of forests in the Mediterranean under climate change, with niche- and process-based models: CO2 matters!: PREDICTING THE FUTURE OF FORESTS UNDER CLIMATE CHANGE', *Global Change Biology* 17(1), pp. 565-579 (DOI: 10.1111/j.1365-2486.2010.02254.x).

Kelemen, A., et al., 2014, *Thematic study: Environmental risk management and climate change*, CENTRAL EUROPE Programme Joint Technical Secretariat.

Kern, K. and Bulkeley, H., 2009, 'Cities, Europeanization and multi-level governance: governing climate change through transnational municipal networks', *Journal of Common Market Studies* 47(2), pp. 309–332.

Kietäväinen, A., et al., 2011, *Lapin matkailun sopeutuminen ilmastonmuutokseen - Clim-ATIC -hankkeen työraportti (Adaptation to climate change of the tourism sector in Lapland - working report of the Clim-ATIC project)*,.

Koch, R. and Schöner, W., 2015,'Spatiotemporal analysis of snow trends in Austria', conference paper presented at: EGU General Assembly 2015, Vienna, Austria, 2015.

Kourkgy, C., et al., 2016, 'Onset of autumn shapes the timing of birth in Pyrenean chamois more than onset of spring' Coulson, T. (ed.), *Journal of Animal Ecology* 85(2), pp. 581-590 (DOI: 10.1111/1365-2656.12463).

Kuglitsch, F. G., et al., 2010, 'Heat wave changes in the eastern Mediterranean since 1960', *Geophysical Research Letters* 37, p. L04802 (DOI: 10.1029/2009GL041841).

Kurnik, B., et al., 2015, 'An assessment of actual evapotranspiration and soil water deficit in agricultural regions in Europe', *International Journal of Climatology* 35(9), pp. 2451-2471 (DOI: 10.1002/joc.4154).

Lakatos, F. and Molnár, M., 2009, 'Mass mortality of beech (Fagus sylvatica L.) in South-West Hungary', *Acta Silvatica et Lignaria Hungarica* 5, pp. 75–82.

Lavalle, C., et al., 2009, 'Climate change in Europe. 3. Impact on agriculture and forestry. A review', *Agronomy for Sustainable Development* 29(3), pp. 433-446 (DOI: 10.1051/agro/2008068).

Lehner, F., et al., 2016, 'Future risk of record-breaking summer temperatures and its mitigation', *Climatic Change*, pp. 1-13 (DOI: 10.1007/s10584-016-1616-2).

Lelieveld, J., et al., 2012, 'Climate change and impacts in the Eastern Mediterranean and the Middle East', *Climatic Change* 114(3-4), pp. 667-687 (DOI: 10.1007/s10584-012-0418-4).

Lelieveld, J., et al., 2014, 'Model projected heat extremes and air pollution in the eastern Mediterranean and Middle East in the twenty-first century', *Regional Environmental Change* 14(5), pp. 1937-1949 (DOI: 10.1007/s10113-013-0444-4).

Lenoir, S., et al., 2011, 'Modelled spatial distribution of marine fish and projected modifications in the North Atlantic Ocean: NICHE MODELLING AND FISH BIOGEOGRAPHY', *Global Change Biology* 17(1), pp. 115-129 (DOI: 10.1111/j.1365-2486.2010.02229.x).

Lexer, W., et al., 2013, *Climate Adaptation Policies, Governance and the Science-Policy Interface in Alpine Countries and Regions*, Country Report Austria.

Lindner, M., et al., 2010, 'Climate change impacts, adaptive capacity, and vulnerability of European forest ecosystems', *Forest Ecology and Management* 259(4), pp. 698-709 (DOI: 10.1016/j.foreco.2009.09.023).

Lionello, P., et al., eds., 2006, *Mediterranean climate variability*, Elsevier, Amsterdam; Oxford.

Lionello, P. and Scarascia, L., 2018, 'The relation between climate change in the Mediterranean region and global warming', *Regional Environmental Change* 18(5), pp. 1481-1493 (DOI: 10.1007/s10113-018-1290-1).

Llasat, M. C., et al., 2017,'Coping with floods in a climate change framework in the Pyrenees: from the November 1982 event to the June 2013 event', conference paper presented at: 2nd International colloquium on climate change in mountain areas, PYRADAPT 2017, 2017.

López-Moreno, J. I., et al., 2009, 'Impact of climate change on snowpack in the Pyrenees: Horizontal spatial variability and vertical gradients', *Journal of Hydrology* 374(3-4), pp. 384-396 (DOI: 10.1016/j.jhydrol.2009.06.049).

López-Moreno, J. I., et al., 2011, 'Effects of climate change on the intensity and frequency of heavy snowfall events in the Pyrenees', *Climatic Change* 105(3-4), pp. 489-508 (DOI: 10.1007/s10584-010-9889-3).

López-Moreno, J. I., et al., 2016, 'Thinning of the Monte Perdido Glacier in the Spanish Pyrenees since 1981', *The Cryosphere* 10(2), pp. 681-694 (DOI: 10.5194/tc-10-681-2016).

Losada, I., et al., 2014, *Cambio climático en la costa española*, Oficina Española de Cambio Climático, Ministerio de Agricultura, Alimentación y Medio Ambiente.

Luchetta, A., et al., 2010, 'New observations of CO2-induced acidification in the northern Adriatic Sea over the last quarter century', *Chemistry and Ecology* 26(S1), pp. 1–17.

Ludwig, W., et al., 2009, 'River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers for ecosystem changes during past and future decades?', *Progress in Oceanography* 80(3-4), pp. 199-217 (DOI: 10.1016/j.pocean.2009.02.001).

Luomaranta, A., et al., 2014, 'Multimodel estimates of the changes in the Baltic Sea ice cover during the present century', *Tellus A* 66(22617) (DOI: 10.3402/tellusa.v66.22617).

Mair, V., et al., 2011, *PermaNET - Permafrost Long-term Monitoring Network. Synthesis report*, INTERPRAEVENT Journal series 1 No Report 3.

Mariotti, A., 2010, 'Recent Changes in the Mediterranean Water Cycle: A Pathway toward Long-Term Regional Hydroclimatic Change?', *Journal of Climate* 23(6), pp. 1513-1525 (DOI: 10.1175/2009JCLI3251.1).

Mariotti, A., et al., 2015, 'Long-term climate change in the Mediterranean region in the midst of decadal variability', *Climate Dynamics* 44(5-6), pp. 1437-1456 (DOI: 10.1007/s00382-015-2487-3).

Matías, L., 2012, 'Cambios en los límites de distribución de especies arbóreas como consecuencia de las variaciones climáticas', *Ecosistemas* 21(3), pp. 91-96 (DOI: 10.7818/ECOS.2012.21-3.12).

Mátyás, C., et al., 2010, 'Future of beech in Southeast Europe from the perspective of evolutionary ecology', *Acta Silvatica et Lignaria Hungarica* 6, pp. 91–110.

May, W., et al., 2016,'Projected Change—Atmosphere', in: Quante, M. and Colijn, F. (eds), *North Sea Region Climate Change Assessment*, Springer International Publishing, Cham, pp. 149-173.

Meaurio, M., et al., 2017, 'Assessing the hydrological response from an ensemble of CMIP5 climate projections in the transition zone of the Atlantic region (Bay of Biscay)', *Journal of Hydrology* 548, pp. 46-62 (DOI: 10.1016/j.jhydrol.2017.02.029).

MED Programme 2007-2013, 2017, *Final Implementation Report 2015-16*, draft – first version 7/02/2017.

Menzel, S. and Pütz, M., 2013, *Climate Adaptation Policies and Governance in Alpine Countries*, Transnational Synthesis Report of Work Package 4 in the C3-Alps Project.

Micheli, F., et al., 2013, 'Cumulative human impacts on Mediterranean and Black Sea marine ecosystems: assessing current pressures and opportunities' Meador, J. P. (ed.), *PLoS ONE* 8(12), p. e79889 (DOI: 10.1371/journal.pone.0079889).

Mieszkowska, N., et al., 2009,'Chapter 3 Effects of Climate Change and Commercial Fishing on Atlantic Cod Gadus morhua', in: *Advances in Marine Biology*, Elsevier, pp. 213-273.

Montesarchio, M., et al., 2013, *Analysis of the downscaled climate simulations performed with the COSMO-CLM model, including assessment of the bias.*, Orientgate Project Report.

Morán-Tejeda, E., et al., 2017,'Changes in Climate, Snow and Water Resources in the Spanish Pyrenees: Observations and Projections in a Warming Climate', in: Catalan, J. et al. (eds), *High Mountain Conservation in a Changing World*, Springer International Publishing, Cham, pp. 305-323.

Moreno, J. M., 2014, *Forest fires under climate, social and economic changes in Europe, the Mediterranean and other fire-affected areas of the world*, FUME project.

Muir, D., et al., 2014, 'Challenges and opportunities in climate change adaptation for communities in Europe's northern periphery', *Ocean & Coastal Management* 94, pp. 1-8 (DOI: 10.1016/j.ocecoaman.2014.03.017).

Navarra, A. and Tubiana, L., 2013a, *Regional assessment of climate change in the Mediterranean*, Springer, Dordrecht, the Netherlands.

Navarra, A. and Tubiana, L., eds., 2013b, *Regional assessment of climate change in the Mediterranean. Volume 1: Air, sea and precipitation and water*, Springer, Dordrecht, the Netherlands.

Navarro-Serrano, F. M. and López-Moreno, J. I., 2017, 'Análisis espacio-temporal de los eventos de nevadas en el Pirineo español y su relación con la circulación atmosférica', *Cuadernos de Investigación Geográfica* 43(1), p. 233 (DOI: 10.18172/cig.3042).

Nilsson, A. E., et al., 2017, 'Towards extended shared socioeconomic pathways: A combined participatory bottom-up and top-down methodology with results from the Barents region', *Global Environmental Change* 45, pp. 124-132 (DOI: 10.1016/j.gloenvcha.2017.06.001).

Nordic Council of Ministers, 2014, *Arctic Co-operation Programme 2015-2017*,.

Nurse, L. A., et al., 2014,'Small islands', in: Barros, V. R. et al. (eds), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1613-1654.

Olesen, J. E., et al., 2011, 'Impacts and adaptation of European crop production systems to climate change', *European Journal of Agronomy* 34(2), pp. 96-112 (DOI: 10.1016/j.eja.2010.11.003).

Olesen, J. E., 2016,'Socio-economic Impacts—Agricultural Systems', in: *North Sea Region Climate Change Assessment*, Springer, pp. 397–407.

Önol, B. and Semazzi, F. H. M., 2009, 'Regionalization of Climate Change Simulations over the Eastern Mediterranean', *Journal of Climate* 22(8), pp. 1944-1961 (DOI: 10.1175/2008JCLI1807.1).

OPCC and CTP, 2013, *Etude sur l'adaptation au changement climatique dans les Pyrénées*, Observatoire Pyrénéen du Changement Climatique (OPCC), Communauté de Travail des Pyrénées (CTP).

Orlowsky, B. and Seneviratne, S. I., 2013, 'Elusive drought: uncertainty in observed trends and short- and long-term CMIP5 projections', *Hydrology and Earth System Sciences* 17(5), pp. 1765-1781 (DOI: 10.5194/hess-17-1765-2013).

ÖROK, 2011, *Österreichisches Raumentwicklungskonzept 2011*,.

OSPAR, 1992, Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention).

OSPAR, 2010, The North-East Atlantic Environment Strategy Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic 2010–2020, (https://www.ospar.org/site/assets/files/1200/ospar_strategy.pdf), OSPAR Commission.

OSPAR, 2017, *Intermediate Assessment 2017*,.

Overland, J. E., et al., 2014, 'Future Arctic climate changes: adaptation and mitigation time scales', *Earth's Future* 2(2), pp. 68-74 (DOI: 10.1002/2013EF000162).

Panagos, P., et al., 2015a, 'Estimating the soil erosion cover-management factor at the European scale', *Land Use Policy* 48, pp. 38-50 (DOI: 10.1016/j.landusepol.2015.05.021).

Panagos, P., et al., 2015b, 'The new assessment of soil loss by water erosion in Europe', *Environmental Science & Policy* 54, pp. 438–447.

Pardowitz, T., 2015, Anthropogenic changes in the frequency and severity of European winter storms, Dissertation FUDISS_derivate_000000017018, Free University, Berlin.

Pascual, D., et al., 2016, *Methodology to assess climate change impacts in the LIFE MEDACC case study basins: Generation of scenarios, vulnerability maps and quantification of impacts*, No Deliverable 13. LIFE MEDACC.

Patiño, J., et al., 2016, 'Climate threat on the Macaronesian endemic bryophyte flora', *Scientific Reports* 6, p. 29156.

Perez, J., et al., 2015, 'Statistical multi-model climate projections of surface ocean waves in Europe', *Ocean Modelling* 96, pp. 161-170 (DOI: 10.1016/j.ocemod.2015.06.001).

Pesonen, H.-L. and Horn, S., 2014, 'Evaluating the climate SWOT as a tool for defining climate strategies for business', *Journal of Cleaner Production* 64, pp. 562-571 (DOI: 10.1016/j.jclepro.2013.10.013).

Pinnegar, J. K., et al., 2016,'Socio-economic Impacts—Fisheries', in: Quante, M. and Colijn, F. (eds), *North Sea Region Climate Change Assessment*, Springer International Publishing, Cham, pp. 375–395.

Pons, M., et al., 2015, 'The vulnerability of Pyrenean ski resorts to climate-induced changes in the snowpack', *Climatic Change* 131(4), pp. 591-605 (DOI: 10.1007/s10584-015-1400-8).

Quante, M. and Colijn, F., eds., 2016, *North Sea Region Climate Change Assessment*, Springer International Publishing, Cham.

Radić, V., et al., 2014, 'Regional and global projections of twenty-first century glacier mass changes in response to climate scenarios from global climate models', *Climate Dynamics* 42(1-2), pp. 37-58 (DOI: 10.1007/s00382-013-1719-7).

Rafaelsen, B., et al., 2017, *Study on macro-regional strategies and their links with cohesion policy. Final Report*, EUROPEAN COMMISSION DIRECTORATE-GENERAL REGIONAL AND URBAN POLICY.

Räisänen, J., et al., 2004, 'European climate in the late twenty-first century: regional simulations with two driving global models and two forcing scenarios', *Climate Dynamics* 22(1), pp. 13-31 (DOI: 10.1007/s00382-003-0365-x).

Raitsos, D. E., et al., 2010, 'Global climate change amplifies the entry of tropical species into the eastern Mediterranean Sea', *Limnology and Oceanography* 55(4), pp. 1478-1484 (DOI: 10.4319/lo.2010.55.4.1478).

Rico, I., et al., 2017,'First evidence of permafrost occurrence in a steep rock wall in the Pyrenees: The Vignemale North Face.', conference paper presented at: VI Iberian Congress of the International Permafrost Association, Mieres (Spain), June 2017.

Rixen, C. and Wipf, S., 2017,'Non-equilibrium in Alpine Plant Assemblages: Shifts in Europe's Summit Floras', in: Catalan, J. et al. (eds), *High Mountain Conservation in a Changing World*, Springer International Publishing, Cham, pp. 285-303.

Rowell, D. P., 2005, 'A scenario of European climate change for the late twenty-first century: seasonal means and interannual variability', *Climate Dynamics* 25(7-8), pp. 837-849 (DOI: 10.1007/s00382-005-0068-6).

Russo, S., et al., 2014, 'Magnitude of extreme heat waves in present climate and their projection in a warming world', *Journal of Geophysical Research: Atmospheres* 119(22), pp. 12500-12512 (DOI: 10.1002/2014JD022098).

Sabrié, M.-L., et al., 2016, *The Mediterranean Region under climate change: a scientific update*,.

Santini, M. and Valentini, R., 2011, 'Predicting hot-spots of land use changes in Italy by ensemble forecasting', *Regional Environmental Change* 11(3), pp. 483-502 (DOI: 10.1007/s10113-010-0157-x).

Santos, F. D., et al., 2004, 'Climate change scenarios in the Azores and Madeira islands', *World Resource Review* 16(4), pp. 473–491.

Satta, A., et al., 2015, *Application of a Multi-Scale Coastal Risk Index at Regional and Local Scale in the Mediterranean*, Technical Report, Plan Bleu UNEP/MAP Regional Activity Centre.

Sauter, R., et al., 2013, *Impacts of climate change on all European islands, A report by the Institute for European Environmental Policy (IEEP) for the Greens/EFA of the European Parliament*, nstitute for European Environmental Policy.

SCC, 2017, Article on Climate Change to the Carpathian Convention (SCC/04/2017/FINAL), Secretariat of the Carpathian Convention (SCC).

Schneider, C., et al., 2013, 'How will climate change modify river flow regimes in Europe?', *Hydrology and Earth System Sciences* 17(1), pp. 325-339 (DOI: 10.5194/hess-17-325-2013).

Schöner, W., et al., 2010, *Anpassungsstrategien an den Klimawandel für Österreichs Wasserwirtschaft*, Im Auftrag des BMLFUW und der Länder, Zentralanstalt für Meteorologie und Geodynamik, TU-Wien.

Schöner, W., et al., 2016, *Snow in Austria during the instrumental period – spatiotemporal patterns and their causes - relevance for future snow scenarios*, Publizierbarer Endbericht, Klima- und Energiefonds.

Schöner, W., et al., 2018, 'Spatial-temporal patterns of snow depth within the Swiss-Austrian Alps for the past half century (1961 to 2012) and linkages to climate change', *International Journal of Climatology (revised version submitted)*.

Schrum, C., et al., 2016,'Projected Change—North Sea', in: Quante, M. and Colijn, F. (eds), *North Sea Region Climate Change Assessment*, Springer International Publishing, Cham, pp. 175-217.

Schuur, E. A. G., et al., 2015, 'Climate change and the permafrost carbon feedback', *Nature* 520(7546), pp. 171-179 (DOI: 10.1038/nature14338).

Screen, J. A. and Simmonds, I., 2010, 'The central role of diminishing sea ice in recent Arctic temperature amplification', *Nature* 464(7293), pp. 1334-1337 (DOI: 10.1038/nature09051).

Serquet, G., et al., 2011, 'Seasonal trends and temperature dependence of the snowfall/precipitation-day ratio in Switzerland: SNOWFALL/PRECIPITATION-DAY RATIO', *Geophysical Research Letters* 38(7), p. n/a-n/a (DOI: 10.1029/2011GL046976).

Sevault, F., et al., 2014, 'A fully coupled Mediterranean regional climate system model: design and evaluation of the ocean component for the 1980–2012 period', *Tellus A: Dynamic Meteorology and Oceanography* 66(1), p. 23967 (DOI: 10.3402/tellusa.v66.23967).

SicAdapt, 2013, *Adapting INTERREG 2014 - 2020 to Climate Change*, SicAdapt! Recommendations for INTERREG V.

Silva, E. D., et al., 2012, 'Does natural regeneration determine the limit of European beech distribution under climatic stress?', *Forest Ecology and Management* 266, pp. 263-272 (DOI: 10.1016/j.foreco.2011.11.031).

Sirotenko, O. D. and Abashina, E. V., 2008, 'Modern climate changes of biosphere productivity in Russia and adjacent countries', *Russian Meteorology and Hydrology* 33(4), pp. 267-271 (DOI: 10.3103/S1068373908040110).

Siwkcki, R. and Ufnalski, K., 1998, 'Review of oak stand decline with special reference to the role of drought in Poland', *Forest Pathology* 28(2), pp. 99-112 (DOI: 10.1111/j.1439-0329.1998.tb01171.x).

Slangen, A. B. A., et al., 2014, 'Projecting twenty-first century regional sea-level changes', *Climatic Change* 124(1–2), pp. 317-332 (DOI: 10.1007/s10584-014-1080-9).

Spada, G., et al., 2013, 'The gravitationally consistent sea-level fingerprint of future terrestrial ice loss: Sea-Level Fingerprint of Future Ice Loss', *Geophysical Research Letters* 40(3), pp. 482-486 (DOI: 10.1029/2012GL053000).

Spinoni, J., et al., 2015a, 'Heat and Cold Waves Trends in the Carpathian Region from 1961 to 2010: Heat and Cold Waves in the Carpathian Region', *International Journal of Climatology* 35(14), pp. 4197-4209 (DOI: 10.1002/joc.4279).

Spinoni, J., et al., 2015b, 'Spatial patterns of European droughts under a moderate emission scenario', *Advances in Science and Research* 12, pp. 179-186 (DOI: 10.5194/asr-12-179-2015).

Stagge, J. H., et al., 2015, *Future meteorological drought: projections of regional climate models for Europe*, Drought R&SPI Technical Report No 25 No Technical Report No 25, Fostering European Drought Research and Science-Policy Interfacing.

Sundtoft, T., 2018, *The Nordic countries in the green transition – more than just neighbours*, Nordic Council of Ministers.

Szuba, G., 2017,'EU MAcro-Regional Strategy for the Carpathian Region', Modra, Slovak Republic, 2017.

Tarife, R., et al., 2012, 'Análisis de los extremos pluviométricos en las islas Canarias y su relación con el índice NAO', *Publicaciones de la Asociación Española de Climatología. Serie A; 8*.

Tatarinov, F. A. and Cienciala, E., 2009, 'Long-term simulation of the effect of climate changes on the growth of main Central-European forest tree species', *Ecological Modelling* 220(21), pp. 3081-3088 (DOI: 10.1016/j.ecolmodel.2009.01.029).

ter Hofstede, R., et al., 2010, 'Regional warming changes fish species richness in the eastern North Atlantic Ocean', *Marine Ecology Progress Series* 414, pp. 1-9 (DOI: 10.3354/meps08753).

Touratier, F. and Goyet, C., 2011, 'Impact of the Eastern Mediterranean Transient on the distribution of anthropogenic CO2 and first estimate of acidification for the Mediterranean Sea', *Deep Sea Research Part I: Oceanographic Research Papers* 58(1), pp. 1-15 (DOI: 10.1016/j.dsr.2010.10.002).

Truong, J. and Menzel, S., 2012, *Evaluation of the CLISP Transnational Strategy for Climate Proof Spatial Planning.*, Deliverable of WP4 in the C3-Alps project, Swiss Federal Research Institute WSL.

Turco, M., et al., 2017, 'Bias correction and downscaling of future RCM precipitation projections using a MOS-Analog technique: MOS-ANALOG PRECIPITATION PROJECTIONS', *Journal of Geophysical Research: Atmospheres* 122(5), pp. 2631-2648 (DOI: 10.1002/2016JD025724).

UfM, 2014, Operational Modalities of the Union for the Mediterranean Climate Change Expert Group (UfMCCEG), (https://ufmsecretariat.org//wp-content/uploads/2014/10/UfMCCEG_OperationalModalities.pdf), Union for the Mediterranean.

Ulbrich, U., et al., 2013,'Past and Current Climate Changes in the Mediterranean Region', in: Navarra, A. and Tubiana, L. (eds), *Regional Assessment of Climate Change in the Mediterranean*, Springer Netherlands, Dordrecht, pp. 9-51.

Umweltbundesamt, 2007,'Wald und Waldnutzung', in: *Umweltsituation in Österreich: achter Umweltkontrollbericht des Umweltbundesamtes*, Austrian Federal Environment Agency (Umweltbundesamt), Vienna, pp. 95-104.

Umweltbundesamt, 2013,'Landwirtschaft und Wald', in: *Umweltsituation in Österreich: Zehnter Umweltkontrollbericht des Umweltbundesamtes*, Austrian Federal Environment Agency (Umweltbundesamt), Vienna, pp. 95-115.

UNEP, 2007, *Carpathians Environment Outlook (KEO)*,.

UNEP/MAP, 2009, Marrakesh Declaration (UNEP(DEPI)/MED IG.19/8).

UNEP/MAP, 2016a, *Mediterranean strategy for sustainable development 2016-2025. Investing in environmental sustainability to achieve social and economic development*, UNEP/MAP, Plan Bleu, Regional Activity Centre.

UNEP/MAP, 2016b, *Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas, (DEPI)/MED IG.22/28., Decision IG.22/6, 19th Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean*,.

UNEP/MAP/PAP, 2008, Protocol on integrated coastal zone management in the Mediterranean, (https://www.pap-thecoastcentre.org/razno/PROTOCOL%20ENG%20IN%20FINAL%20FORMAT.pdf), Split: PAP/RAC.

UNEP/MAP/PAP, 2015, *Guidelines for Adapting to Climate Variability and Change along the Mediterranean Coast*, UNEP/MAP / PAP/RAC.

Van Well, L. and Scherbenske, S. L., 2014, 'Towards a Macroregional Climate Change Adaptation Strategy in the Baltic Sea Region', *Environment and Planning C: Government and Policy* 32(6), pp. 1100-1116 (DOI: 10.1068/c11243).

Verhofstede, B., et al., 2011, *Comparison of climate change effects across North Sea countries*, Climate Proof Areas (CPA) project.

Vicente-Serrano, S. M., et al., 2016, *Historical trends in climate, land use and water demand*, No Deliverable 12. LIFE, MEDACC.

Vousdoukas, M. I., et al., 2017, 'Extreme sea levels on the rise along Europe's coasts', *Earth's Future* 5(3), pp. 304-323 (DOI: 10.1002/2016EF000505).

Ward, R. D., et al., 2016, 'Impacts of climate change on mangrove ecosystems: a region by region overview', *Ecosystem Health and Sustainability* 2(4), p. e01211 (DOI: 10.1002/ehs2.1211).

Werners, S., et al., 2014, *Future imperfect: climate change and adaptation in the Carpathians*, GRID-Arendal.

World Bank, 2015, *Water and Climate Adaptation Plan for the Sava River Basin: Annex 1. Development of the Hydrologic Model for the Sava River Basin*, World Bank.

Zampieri, M., et al., 2012, 'Regional climate change in the Northern Adriatic', *Physics and Chemistry of the Earth, Parts A/B/C* 40-41, pp. 32-46 (DOI: 10.1016/j.pce.2010.02.003).

Zappa, G., et al., 2013, 'A Multimodel Assessment of Future Projections of North Atlantic and European Extratropical Cyclones in the CMIP5 Climate Models', *Journal of Climate* 26(16), pp. 5846-5862 (DOI: 10.1175/JCLI-D-12-00573.1).

Zemp, M., et al., 2008,'Glacier fluctuations in the European Alps, 1850-2000: an overview and a spatiotemporal analysis of available data', in: Orlove, B. S. et al. (eds), *Darkening peaks: glacier retreat, science, and society*, University of California Press, Los Angeles, CA, USA, pp. 152-167.

Zemp, M., et al., 2015, 'Historically unprecedented global glacier decline in the early 21st century', *Journal of Glaciology* 61(228), pp. 745-762 (DOI: 10.3189/2015JoG15J017).

European Topic Centre on Climate Change impacts, vulnerability and Adaptation (ETC/CCA)
c/o Fondazione CMCC - Centro Euro-Mediterraneo sui Cambiamenti Climatici
V.le Berti Pichat 6/2
40127 Bologna, Italy
Web: http://cca.eionet.europa.eu/
Email: silvia.medri@cmcc.it

The European Topic Centre on Climate Change impacts, vulnerability and Adaptation (ETC/CCA) is a consortium of European institutes under contract of the European Environment Agency.

European Environment Agency
European Topic Centre on Climate Change
Impacts, Vulnerability and Adaptation